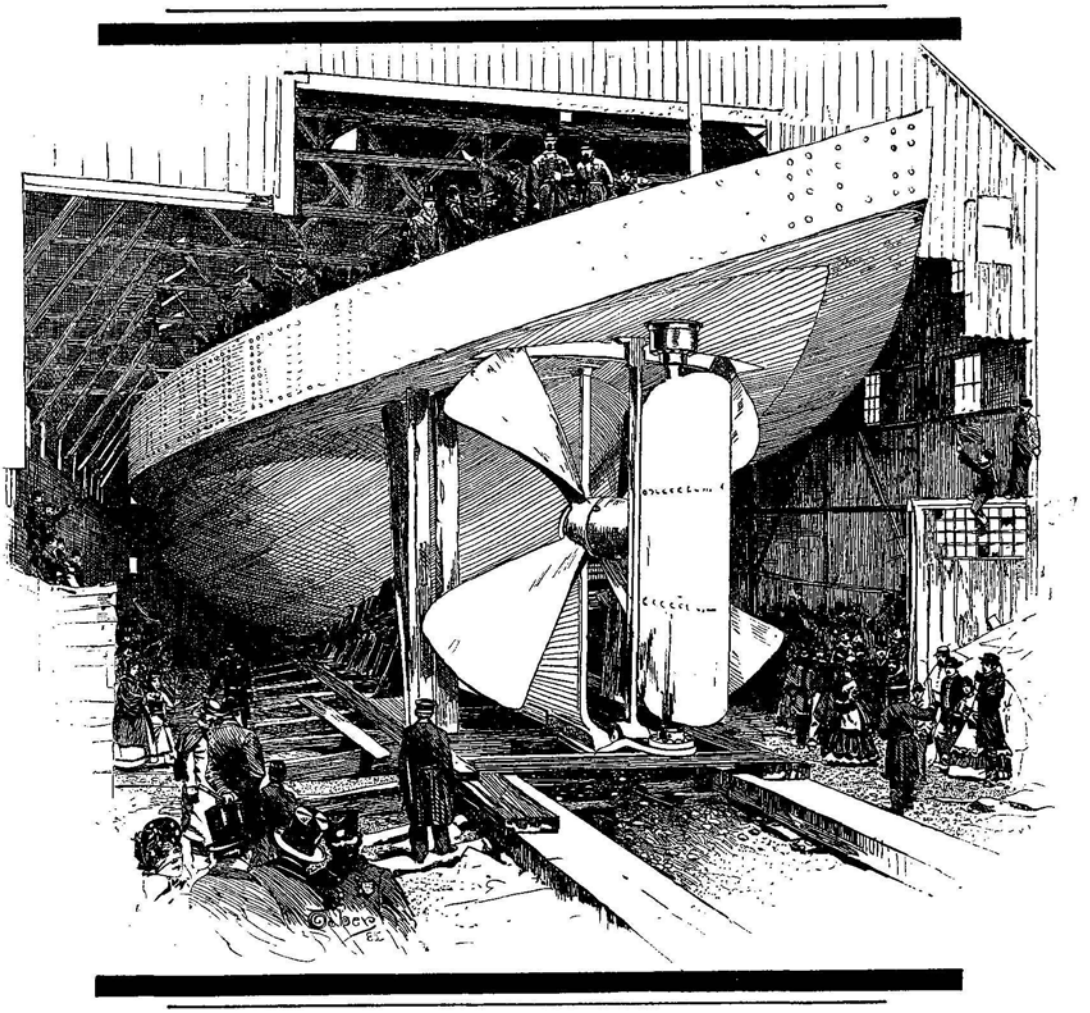
D-413
File: NPS
General

Monitor Builders: A Historical Study of the Principal Firms and Individuals Involved in the Construction of

IN
STORAGE

USS *Monitor*



Color Scans
10/24/2002

ON MICROFILM

PLEASE RETURN TO:
TECHNICAL INFORMATION CENTER
DENVER SERVICE CENTER
NATIONAL PARK SERVICE

Cover illustration: Delamater Ironworks, one of a handful of New York firms that built Monitor, was active in ironclad construction throughout the Civil War years. The monitor Dictator slides down the ways from a covered shipyard shed on December 27, 1863. (Harper's Weekly)

Monitor Builders: A Historical Study of the Principal Firms and Individuals Involved in the Construction of

USS *Monitor*

By

WILLIAM N. STILL, JR. Ph.D.
Professor of History
East Carolina University

Prepared for
United States Department of Commerce
National Oceanic and Atmospheric Administration
Marine and Estuarine Management Division
Washington, D.C.

Published by
National Maritime Initiative
Division of History
National Park Service
Department of the Interior

Washington, D.C.
1988

Acknowledgements

I would like to express my appreciation to the following individuals and institutions for their help: K. Jack Bauer, Rensselaer Polytechnic Institute; James P. Delgado and Kevin J. Foster, National Park Service; Pat Guyette, Joyner Library, East Carolina University; Harold Langley, Armed Forces History Division, The National Museum of American History; John D. Milligan, State University of New York at Buffalo; Stuart Morgan, Peabody Museum; Captain Ernest Peterkin, USNR (Ret.); Virginia Wood; and the staff of the Eleutherian Mills-Hagley Foundation Library, Wilmington, Delaware.

Table of Contents

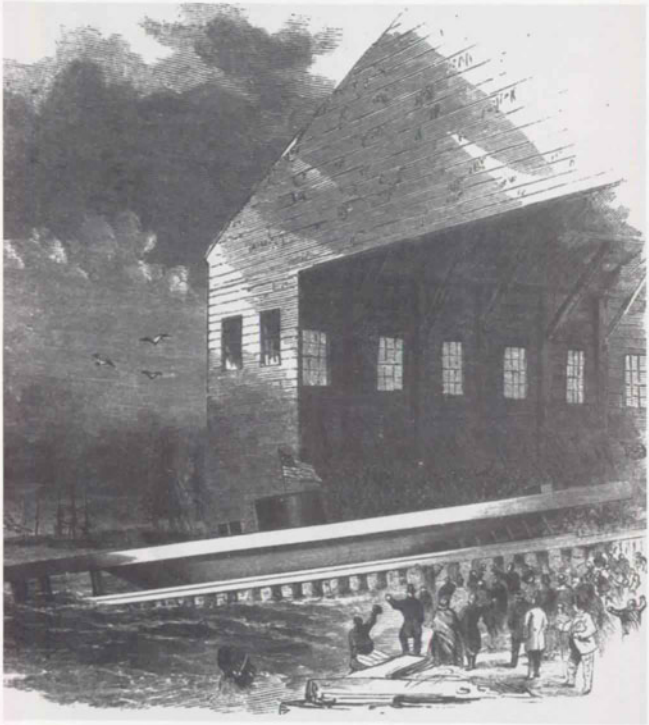
Foreword

This analysis of the firms involved in casting, forging, manufacturing, and assembling John Ericsson's *Monitor* is the first such study of this important aspect of the oft-researched ironclad. Dr. Still, noted Civil War naval historian and author of several works on Confederate ironclads and *Monitor,* was an ideal choice to research and write *Monitor Builders*.

The study was done under contract with the National Maritime Initiative of the National Park Service to aid in the preparation of a historical context study to determine the various aspects of *Monitor's* significance. This work was done under provision of a cooperative agreement with the National Oceanic Atmospheric Administration (NOAA) to provide technical support and expertise to NOAA's program of research and management of the shipwrecked remains of USS *Monitor*. The National Park Service contributed cultural resource management policies, procedures for applying for research permits, an archeological research design, the before-mentioned historical context study, and prepared a successful nomination for *Monitor's* designation as a National Historic Landmark.

The industrial history and archeology of 19th century America is now the subject of considerable interest and attention. *Monitor,* significant to many aspects of the history and culture of the United States, is clearly shown by Dr. Still to be both a product and a stimulator of the American industrial revolution.

James P. Delgado
Maritime Historian of the National Park Service



Launch of Monitor, September, 1862. (U.S. Naval Historical Center)

I. Iron Manufacturing

A. Early Development

USS *Monitor* was the product of a number of ironworks, foundries, and machinery-manufacturing firms. With the exception of one Baltimore company, all firms were located in New York State, with the majority in New York City. Although a large number were small establishments selected because of the necessity to complete the ship as quickly as possible, a few were large, prosperous, and well-established companies. Their composite history illustrates industrial growth of the United States during the 19th century, especially its initial development. *Monitor's* "builders" were mechanics, inventors, engineers, and businessmen. Although they were intimately associated with technological change, they were generally self-taught, working largely without the benefit of theoretical background.

The physical environment of the United States provided both the incentive and the means to develop new industry, transportation facilities, and the accompanying technology. The United States achieved extraordinary expansion during the first half of the 19th century—nearly 1.8 million square miles—yet its population remained small and scattered. Transportation facilities to link up the far-flung territory were essential, and this need provided opportunities for inventiveness and exploitation. The transportation revolution cheapened and facilitiated the movement of goods and provided an impetus for industrial growth. The country's natural resources, virtually untapped at the century's beginning, were discovered and developed, particularly coal and iron.

The 19th century is sometimes described as the age of coal, iron, and steel, with the United States emerging as a leading nation in that epochal age.[1] At the beginning of the century, the great bulk of manufactured iron was produced by smelting and refining.[2] Small ironworks, found in every state, were based upon ore from a nearby mine or bog and relied on charcoal for fuel. In the 1820s, with the emergence of small factories, specialization appeared in the manufacture of iron products. The manufacture of farm machinery and implements, followed by household products, provided the major market for the iron industry.[3]

The development of rolling mills was a major factor in the iron industry's expansion. The first angle iron, and probably the first regular bars, were rolled in the United States in 1817.[4] By 1830 the manufacture of rolled and hammered iron products amounted to 113,000 tons. During the following two decades, the production of rolled iron would expand rapidly, totalling more than 500,000 tons by the outbreak of the Civil War.[5] In 1860 almost one million tons of iron ore were produced. In that year there were 256 ironworks in 20 states producing bars, sheet, and railroad iron.[6]

Almost 60 percent of the country's iron ore in 1860 came from Pennsylvania, followed by Ohio and New York. The Empire State's output totalled 74,645 net tons from 15 furnaces. Most of the ore was found in two localities, the southern highlands and the area around Lake Champlain. New York's rise to distinction in iron manufacturing dates from the 1830s. By 1840 New York emerged as the leading producer in bar, sheet, and railroad iron, with 195 establishments turning out more than four million dollars' worth.[7] Among these were several ironworks later involved in building *Monitor*. Two cities, New York and Troy, became leaders in the fabrication of iron and steel products.

B. Holdane & Company

In New York City, Holdane & Company, a small establishment that specialized in "Boiler and Sheet Iron, Rivets, Welded Tubes, Etc." subcontracted to provide 125 tons of armor plate, as well as bar and angle iron for *Monitor*.[8] Little has been learned about its prewar business activities, and in fact, Trow's New York City Directory for the year ending May 1, 1863, does not list Holdane & Company. Nevertheless, the business continued to exist and prospered during the war and after.

In 1854 Robert G. Dun joined the Mercantile Agency, a firm that specialized in gathering information on merchants and businesses throughout the country. Mercantile's information was frequently used in business transactions involving credit. Rating credit became standard practice and was one criterion used to determine the economic soundness of a merchant or business firm. Dun provided reports on a number of the *Monitor* companies, including Holdane; the earliest such report, dated 1860, states that the company had trouble during the panic of 1857. In January 1860, Dun mentioned that Holdane was "still considerably impaired ... and the indications generally are that they will not soon recover their former good business and position." However, the report also stressed that "they have the reputation of being sharp and shrewd financiers."[9] Apparently part of their decline in business was the result of H. Abbott & Sons removing its account from Holdane. The New York Ironworks had been the exclusive agent for Abbott's Baltimore rolling mill until Abbott decided to establish its own business office in New York City.[10] The secession crisis improved the firm's financial situation. Dun reported on April 11, 1861, one day before Fort Sumter was fired on, that "their business has been lately improved although not as strong as they were [previously]."[11]

C. The Albany Ironworks

Holdane was representative of a number of small establishments scattered throughout New York City. The port had more ironworks than any other locality in the state, but the two largest were at Troy, a small city 150 miles up the Hudson River. Strategically located near large deposits of iron ore, Troy was also a transportation center with water and rail links to New York City.

At the outbreak of the Civil War, eight blast furnaces, 20 forges, three rolling mills, and two foundries were located in Troy.[12] Two establishments, the Albany Ironworks and the Rensselaer Ironworks, produced iron for *Monitor*. Three of the city's leading businessmen, Erastus Corning, John Flack Winslow, and John Griswold, all associated with the two ironworks, were involved in building *Monitor*.

John Winslow and John Griswold's involvement with *Monitor* is well known, but that of Erastus Corning is not. According to Corning's biographer, he was probably a silent partner; in 1861 he was a member of Congress and thus could not be a contractor with the Federal government.[13] Corning was a native New Englander who served as an apprentice in a Troy hardware store. He began his career as an iron manufacturer in 1826, when he purchased a small foundry and rolling

John Winslow, managing partner of the Albany Ironworks, was called an iron-working "genius." His talents were put to good use in the difficult task of casting the parts needed to assemble the prefabricated Monitor in a few months' time. (Dictionary of American Biography)

mill that specialized in producing nails from imported bar iron. The Albany Nail Factory initially employed 34 workers.[14] Corning personally devoted little time to the factory. Later, shortly after purchasing the Troy establishment, he moved to Albany and became involved in banking, local politics, and railroad promotion. During the first 10 years the nail factory was not a financial success. In 1837 Corning hired John Winslow as manager, who not only ran the company, but eventually became a partner in it. The firm changed its name to Corning, Horner & Winslow, and the factory was renamed the Albany Ironworks.[15]

John Winslow, a New Englander from Vermont, was the son of an ironmaster. After briefly serving as a clerk in a mercantile house, he entered the iron business, working for two years with an ironworks in New Jersey before purchasing a small iron foundry in that state. He had six years of experience in iron manufacturing when he agreed to become manager and a partner of the Albany Ironworks.[16] Although partners in the Albany Ironworks changed, both Corning and Winslow remained associated with it until they retired from professional life. Corning left the actual running of the factory to Winslow, but all major decisions were made with his concurrence.[17]

Yet it was Winslow who developed the ironworks into one of the largest in New York. According to J. Leander Bishop, Winslow was a "genius" in the iron business. He had, according to another authority, an "uncanny sense" of what would prove successful in the manufacture of iron.[18] A year after he took over, the ironworks began puddling, or converting, pig iron into wrought iron. The coming of the railroad offered another opportunity, and by the 1830s, a factory had been added for making boiler rivets and spikes for railroads and vessels. Apparently the Albany Ironworks provided spikes for most of the railroads in New York State and as far west as Cleveland, Ohio.[19] Winslow also redesigned and enlarged the rolling mill at Albany Ironworks. The modified facility included 18 puddling and heating furnaces, four complete trains of rollers, Winslow's patented rotary squeezer, shears, roller lathes, wrought railroad-chair machinery, hammers, and five steam engines to run the different machines.[20] In the 1850s, two additional rolling mills were added, one run by water power and the other by steam, and an axle plant. By the Civil War, the establishment covered some 40 or 50 acres of land with "numerous buildings, constituting a small village in itself."[21] By that date more than 750 men were employed.

Corning and Winslow, as typical enterpreneurs, were involved in a variety of business enterprises. Corning was prominent in railroad development, particularly on the lines that ultimately became the New York Central system. Following New York Central's consolidation, Corning was elected its first president. Winslow was also involved in railroad and banking enterprises and in later years was president of Rensselaer Polytechnic Institute from 1865 to 1868.

D. The Rensselaer Ironworks

Both Winslow and Corning were investors in a second ironworks located in Troy, which also became involved in building *Monitor*. In 1846 the Troy Vulcan Company erected a rolling mill. In 1853 it was converted to a rail mill and became known as the "Rensselaer Iron Company" and the

John Griswold, proprietor of Troy, New York's Rensselaer Ironworks, successfully combined business and politics in his career. Griswold found business and politics profitably intertwined in the construction of John Ericsson's Monitor. (Dictionary of American Biography)

following year was renamed the "Rensselaer Ironworks." By 1856, its 18 furnaces and four steam-driven roll trains produced 12,650 tons of rail and 862 tons of bar iron.[22] The Rensselaer Ironworks was owned by John A. Griswold, who sold a half interest in the establishment to Corning and Winslow in 1855.[23] By 1860 Rensselaer Ironworks employed 350 men in the manufacture of railroad rails, bar and sheet iron.[24]

Like Corning, John Griswold had begun his career as a clerk in a Troy hardware store. He then worked for a number of firms before entering the iron business. Winslow apparently managed the Rensselaer works as well as the larger Albany Ironworks. Griswold had no experience in iron manufacturing, and in fact, apparently was more interested in politics. He would be elected mayor of Troy in 1855, the year that he sold partnerships in the works to Corning and Winslow. Although he was an unsuccessful candidate for Congress in 1860, he was elected in 1862. One writer mentioned that "it was undoubtedly this combination of business and politics that gave special and distinctive importance to his career."[25] As with the other iron manufacturers, Griswold invested in other businesses, including banks, railroads, and ironworks.

When the Civil War broke out, Troy was recognized as an iron manufacturing center. The Albany and Rensselaer Ironworks together employed more than a thousand men, and were considered the largest producers of railroad and other iron in the United States.[26] Considering their size and prominence, their involvement in government contract work, including the fabrication of iron for warships, was not surprising.

E. Niagara Steam Forge

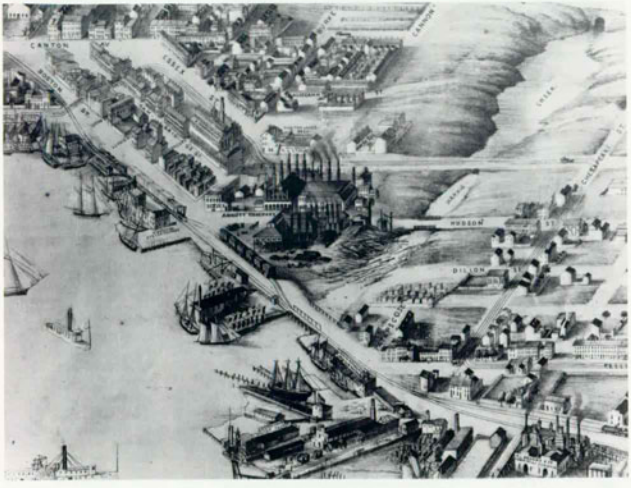
Government work was less straightforward for a smaller company located in Buffalo, 300 miles west of Troy on Lake Erie. The Niagara Steam Forge would manufacture the massive "port stoppers" for *Monitor's* turret.

In 1851 Charles D. Delaney started a small firm that he named the Delaney Forge and Iron Company.[28] In that year the Delaware, Lackawanna & Western Railroad was completed, linking the coal fields in northwestern Pennsylvania and southern New York with Buffalo. It was no coincidence that Delaney's company started that year. To be smelted, iron required coal. The completion of the railroad led to Buffalo's becoming an important iron manufacturing center in the 1850s. Delaney is credited with starting the iron industry in Buffalo.[29]

Delaney, a native of Pennsylvania, entered the iron manufacturing business as an apprentice. In 1831 he moved to Buffalo where he became superintendent of construction of engines for a number of Great Lakes steamers, including the *New York, Pennsylvania,* and *General Porter.*[30] He then went to work at the Novelty Ironworks. In 1841 he built the first locomotive in Buffalo and later the first railroad cars. Delaney started his own ironworks in 1851, which he named the Delaney Forge and Iron Company. In 1853 it became the Niagara Steam Forge and would be known by that name for more than three decades. Because of ill health, Delaney sold out in 1856, but with the financial help of a local banker, T. P. Patchin, who became a partner, he acquired ownership again four years later.[31] By 1861, Delaney was advertising as a manufacturer of railroad car axles, crank axles, track and driving axles, wrought-iron driving wheels, locomotive frames, steamboat propeller shafts and cranks, connecting rods, piston rods, crank pins, mill shafts, anchors, hammered bar iron and shafting of any length and size, and blacksmithing.[32] The Niagara Steam Forge was apparently well equipped to manufacture "port stoppers" and other parts for *Monitor.*

F. H. Abbott & Sons

Only one non-New York establishment was substantially involved in producing ironwork for *Monitor.* H. Abbott & Sons of Baltimore, Maryland, provided armor plate for the turret. As with the Niagara Steam Forge, the Baltimore firm's beginning was related to railroad development. Construction of one of the first railroads in the United States, the Baltimore & Ohio, began in 1828, and by the early 1830s the railroad had proved an economic success for the investors and the city of Baltimore. Business leaders projected the city's future, not only as a port, but as a rail center. Baltimore's potential as a transportation hub persuaded a small group of investors to develop an industrial park near the railroad, on the waterfront. They named the park "Canton."[33]



Horace Abbott's ironworks in Baltimore were one of only two large mills whose machinery could roll the thick iron plates needed to build Monitor. (The Peale Museum, Baltimore)

Peter Cooper was one of those investors. Cooper had designed "Tom Thumb," the first American-built locomotive for the Baltimore & Ohio Railroad.[34] He bought out the other "Canton" speculators and began to develop the property. He started an ironworks, the Canton Ironworks, to repair and construct railroad equipment. In 1836 the works were leased to Horace Abbott.[35]

Abbott, a native of Massachusetts, had been apprenticed to a blacksmith as a young boy. After serving his term of apprenticeship and a brief period as an employee, he established his own blacksmith shop. In 1836 he and his brother moved to Baltimore and rented the Canton Ironworks. He was successful in shifting from manufacturing horsehoes, tools, and small farm implements to producing large wrought-iron shafts, cranks, axles, and other railroad and ship parts. The ironworks received public attention in the 1840s by forging the first large steamship shaft made in this country, a shaft designed for the Russian frigate *Kamtschatka*, built in New York for Czar Nicholas I. The six and one-half ton shaft and connecting rods weighing about two-thirds that amount were exhibited at the New York Exchange as the first heavy engine forgings made in the United States.[36] By 1850 Abbott had gained a national reputation as an ironmaster.

In 1850 he added a rolling mill capable of turning out the largest rolled plate in the country at that time. The mill was enlarged in 1854 and two years later produced 2,000 tons of plate.[37] Abbott continued expanding, adding in 1857 a second rolling mill of the same size and capacity as the first,

a third in 1859 and a fourth in 1861. Mill Number Two contained three heating and two puddling furnaces, a Nasmyth steam hammer, and one pair of 10-foot rolls, the largest in the country. More than likely these were the rolls used to make the plates for *Monitor* and other armored vessels during the Civil War. Mill Number Three was designed to manufacture thin plates for gas pipes, boiler tubes, etc.[38] When the Civil War broke out, Abbott's establishment and the Tredegar Ironworks in Richmond, Virginia, were the two largest in the South. Tredegar would roll *Virginia's* plate and Abbott, *Monitor's*.

II. Machinery Manufacturers

A. Early Development

The mechanization of industry was an integral part of the economic revolution in the United States in the nineteenth century. Alongside blast furnaces and rolling mills developed works for the production of heavy machinery. Blowing engines for blast furnaces, machinery for rolling mills, sawmills, sugar mills, and other industries were developed. The most important products, however, were stationary steam engines, and engines for locomotives, steamships, and steamboats.

The mechanization of the United States, particularly during the first half of the nineteenth century, did not involve a massive shift to new power sources. American industries relied upon water as the main source of power until well into the second half of the century. A Congressional report in 1838 estimated there were some 250 steam-engine builders, mostly small and scattered. They had produced 3,000 steam engines of which 1,860 were stationary engines used primarily in industrial establishments, 350 locomotive engines, and 800 engines for steam vessels.[39]

Although stationary steam engines replaced water-powered machinery very slowly in the United States, the growth of the application of steam power to transportation was phenomenal. Its effect was most important to the country's development. Rosenberg wrote, "It is perhaps not too much to say that the major economic consequence of the acquisition of the steam engine in the New World before the Civil War lay in its application to new forms of transport—the steamboat and later the railroad."[40] This was perhaps an inevitable result of the nation's continental expanse, vast inland distances, and need for suitable transport. The steam engine, first in boats and later locomotives, provided the means for fulfilling this need. From 1830 to 1850 steamboats dominated internal transportation in the United States on the Western rivers and began to move outward to the coast.[41]

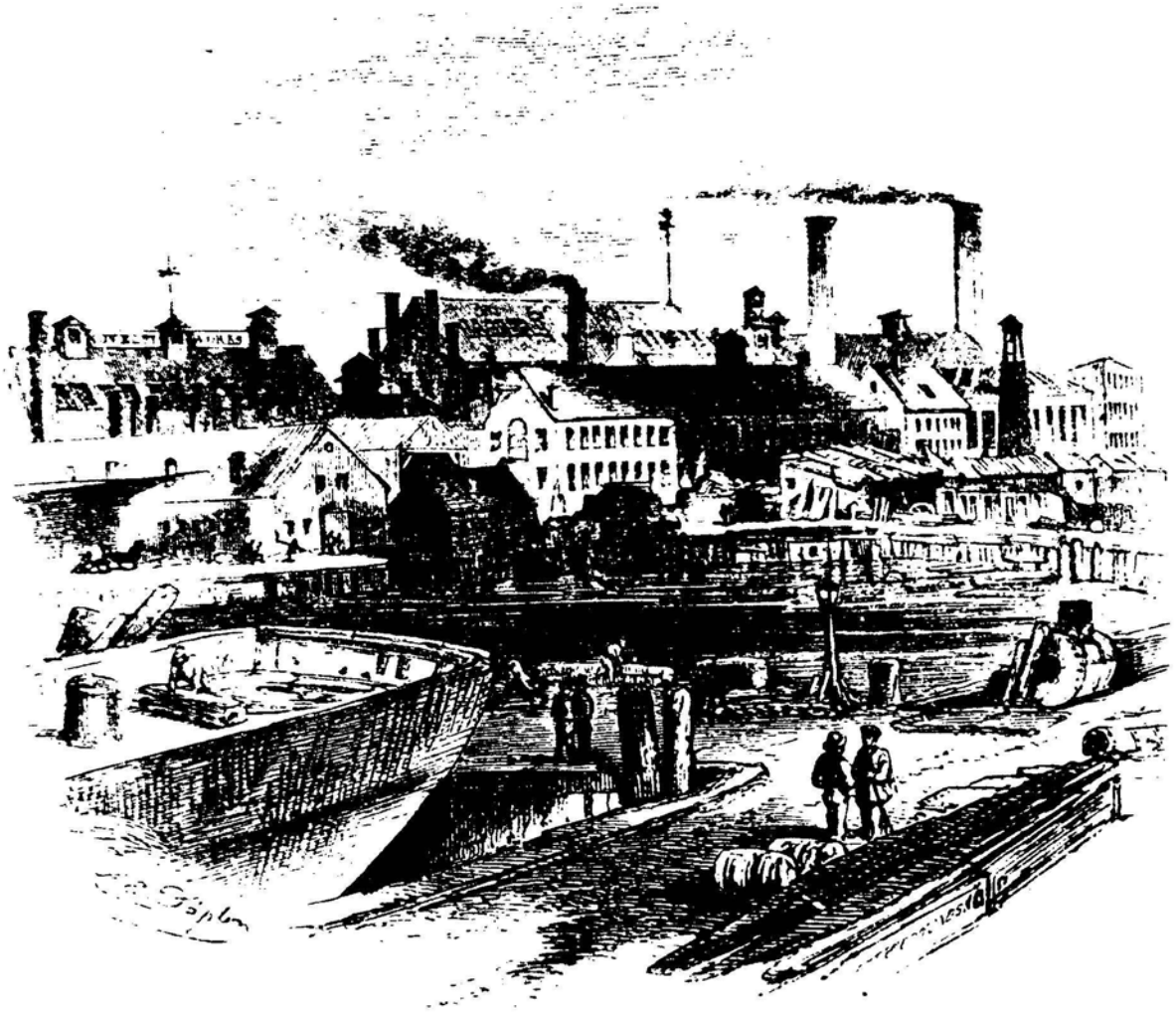
Ocean transportation, however, progressed less rapidly, not establishing steamship service on the Atlantic until 1838—25 years after steamboats were successfully introduced. Technological and economic factors handicapped the growth of oceanic steam transportation. Substantial growth would come in the 1850s. According to Cedric Ridgely-Nevitt in *American Steamships on the Atlantic*, two events resulted in the rapid development of steamships and led to their construction in great numbers. In the late 1840s Congress authorized subsidized mail contracts from New York to various ports in the United States and abroad. The discovery of gold in California also contributed to a shipbuilding boom.[42]

Between 1820 and the outbreak of the Civil War, New York City was the center of the steam-engine industry, particularly power plants for river and ocean vessels. According to Robert Albion, "No other American port could rival the assemblage of talent concentrated in its 'iron works.' Nowhere else in the world, in fact, was there such a group except on the banks of the Clyde around Glasgow."[43] Bishop admiringly wrote:

> It has been truly remarked that, as the city of New York is sustained almost entirely by its commerce, and as this commerce is becoming every year more and more dependent for its prosperity and progress upon the power of the enormous engines by which its most important functions are now performed, the establishments where these engines are invented, made and fitted into ships, which they are destined to propel, constitute really the heart of the metropolis; that the splendor and fashion of Fifth Avenue, and of Union Square, and the brilliancy and ceaseless movement of Broadway, are mere incidents and ornaments of the structure; while these establishments, and those of kindred character and functions, form the foundation on which the whole of the vast edifice reposes.[44]

One of John Ericsson's biographers, William C. Church, quotes a letter to a newspaper that said in 1840 there was no establishment in New York that could "forge an ordinary steam engine shaft." This assertion may explain why Abbott & Sons in Baltimore were contracted to forge the iron shaft for the Russian frigate built in New York City. Yet by 1853, the three largest establishments in New York City specializing in steam engine work employed more than 2,100 men. Four years later, 3,130 men were employed in 17 engine-building companies.[45]

In 1857 a financial panic created a brief but rather severe economic recession in the country. Hundreds of establishments failed or were badly hurt. Recovery was slow, particularly in the shipping and shipbuilding industries. Nevertheless, *The Scientific American* reported in 1861 that the New York City steam-engine manufacturing firms were busy: "at the same time last year there was not so much business going forward as there is at the present moment."[46] Among the engine manufacturing establishments in New York City at that time several worked on *Monitor*, including two well-known companies, Novelty Ironworks, and Delamater Ironworks.



General view of the Novelty Ironworks, New York. (Harper's New Monthly Magazine, Vol. II, No. XII, May 1851)

B. Novelty Ironworks

Novelty Ironworks, which built *Monitor's* turret, was the largest engine-building firm in the city during the 1850s. There is some disagreement about the date that the works was founded, but it apparently occurred in the late 1820s or early 1830s.[47] The establishment was started by Dr. Eliphalet Nott, the president of Union College at Schenectady, an "indefatigable inventor."[48] The occasion was the construction of a steamboat—which he named *Novelty*. Nott chose the name because the vessel would be the first to use a new fuel—anthracite coal—as well as a new type of boiler and engine.[49] To fabricate some of the machinery, including one engine, Nott purchased Burnt Hill Point at the foot of 14th Street on the East River. He converted a number of farm buildings at the Point into shops. He not only used the shops to work on *Novelty*, but other ironwork as well; for example, he began to build home heating stoves known as "Nott Stoves," which he patented.[50]

Hezekian Bliss, a friend of Robert Fulton and a steamboat builder, was hired as superintendent. Under his direction, the ironworks, which gradually became known in the neighborhood as "the Novelty Works," began to take in more marine work. The Novelty Works continued to be the name of a location until 1855 when an incorporated company with the title of "Novelty Iron Works" was established.[51] In 1835 a visitor to the "Novelty Works" wrote, "I found an immense establishment in which were carried on all the different branches and operations in any way connected with making stoves, steam engines, boilers, and almost every article of large machinery, and even steamboats."[52]

In 1838 Nott sold the ironworks to a partnership, Ward, Stillman & Company. Under the new management the works were greatly enlarged and began to concentrate more and more on steam engine construction. Already building a variety of steam engines, the company was apparently one of the first establishments in the United States to construct oscillating engines for use on steamboats. In the late thirties the company gained prestige when it built the machinery for two Spanish steamships, *Lion* and *Eagle*.

In 1842 the man who would largely determine the company's direction for the next quarter century joined Novelty Works as a junior partner. Horatio Allen, one of the better known engineers in the country, remained with Novelty as a partner until its demise after the Civil War. The company was renamed Stillman, Allen & Company, and remained so until 1855 when it was incorporated as Novelty Ironworks with Allen as president.[53]

The New York *Daily Times* reported on December 20, 1854, that Stillman & Allen's business had declined significantly and that a large number of employees had been laid off. More than likely this was the major reason in the decision to incorporate—needed capital could be attracted by selling stock. In addition to Horatio Allen as president, the new officers included Edward Allen, Horatio's brother. Equally important, Edward was the son-in-law of James Brown of Brown Brothers, one of the most powerful banking houses in New York City. James Brown became one of the largest stockholders in Novelty Ironworks. Several years later, one of Brown's sons wrote, "Father owns almost the whole of the stock."[54] In later years another of the Browns, Clarence, also became deeply involved with Novelty. The Browns were not the only important stockholders, however. In 1856 R.G. Dun & Company reported that Novelty Ironworks stock was held by "wealthy men, prominent among them James Brown."[55]

Horatio Allen was born in Schenectady, New York, in 1802 and graduated from Columbia College in 1823.[56] His father was professor of mathematics and natural philosophy and later principal of a large preparatory school at Hyde Park. Allen majored in mathematics and after briefly studying law, he entered the engineering profession, his principal occupation throughout his career.

Allen's professional career began during the "canal era." From the construction of the Erie Canal in the post-War of 1812 years until railroads demonstrated their superiority, the United States witnessed a canal boom, with more than a hundred canals being excavated in all parts of the country. It is not surprising, then, that Allen first worked for the Chesapeake and Delaware Canal Company, then the Delaware and Hudson Coal Company. The latter's efforts to reach the Pennsylvania anthracite coal region resulted in Allen's being sent to England to purchase railroad iron and locomotives. He tested the first locomotive after it was delivered to the United States, and in 1829 the "Stourbridge Lion" became the first railroad engine to run in this country. Although

the engine was never economically a success, Allen's involvement resulted in his appointment as chief engineer of the South Carolina Railroad Company later that year.[57]

As chief engineer, Allen surveyed the railroad's proposed route from Charleston to the Savannah River. He also developed plans for a locomotive that would be built under his supervision at the West Point Foundry in New York. This would be the first railroad engine built in the western hemisphere. Because of this and the "Stourbridge Lion," Allen has been rightfully called the "true father" of locomotives in the United States.[58] Allen remained with the South Carolina Railroad until 1835 when he resigned and went abroad.[59] Three years later he settled in New York City where he was appointed assistant engineer of the Croton aqueduct. The chief engineer was John Jervis, who had been both a friend and colleague in earlier projects. The Croton aqueduct was to provide water for New York City by means of a dam and aqueduct. It took seven years to complete the project, with water first being turned on in 1842.[60]

With the completion of the aqueduct, Allen looked elsewhere to utilize his engineering talents. In 1842 he became a partner in the Novelty Works, but apparently had little initial impact on the company's business activities. The following year he returned to railroads when he was appointed president of the Erie Railroad. His administration was short—less than two years. He achieved some success but was unable to solve the company's financial difficulties, and in 1845 it was sold under foreclosure.[61]

Allen would become involved in one more railroad venture, the Panama Railroad Company, which was incorporated in 1849.[62] There is no evidence, however, that his participation was more than perfunctory. By that time he was concentrating his energies in designing and improving marine steam engines that were being built by Novelty. Allen's interest in marine engines coincided with the accelerated interest in oceanic steam transportation. During the 1840s he took out at least five patents relating to marine steam machinery, including a cutoff valve mechanism that would be used on most of the engines that Novelty built.[63] According to one engineer, Allen was critical of the cutoff valve invented by John Sickel and used on the majority of steam engines. "Horatio Allen ... fought Mr. Sickel during his whole business life and would never allow a Sickel cutoff to be applied in the Novelty Ironworks," wrote Charles Porter.[64] A number of well-known vessels, including *Adriatic* and the Collins steamships *Artic* and *Atlantic,* had engines that included steam and exhaust valves designed by Allen.[65]

Allen was, as one writer said, "a prolific inventor." Between 1841 and 1879, he took out at least 17 patents, the majority related to steam engines.[66] He spent considerable time trying to improve oscillating cylinder engines, which he recommended over side-lever engines for side-wheel steamers. Most of the engines for paddlewheel vessels built by Novelty and the other steam-machinery builders were the side-lever type. A number of the Novelty-built steamers, including *Adriatic* and *Golden Gate,* however, carried oscillating engines.[67]

The Novelty Works during these years became one of the largest establishments in the country for building marine engines. The firm's rise to prominence in steam-machinery construction corresponded with the developing oceanic steamship business. The steam "packet" service in 1855 employed 56 ships, most of them new and at least half built in New York City. The total steamship registered tonnage in the United States jumped from 5,631 tons in 1847 to nearly a hundred thousand in 1860.[68] New York City was the most important shipbuilding center in the country, and Novelty provided the power plants for more steamers than any other establishment.

The names of the vessels in the two decades prior to the Civil War with Novelty-built engines reads like a Who's Who of American vessels for the period. *Southerner,* launched in 1846, was the second actual oceangoing steamship built in the United States. William H. Brown of New York was the shipbuilder and Novelty provided her machinery.[69] In March 1845, Congress passed a law calling for the contracting of the mails to foreign countries, which resulted in the organization of new steamship lines and the construction of new steamers. The Ocean Navigation Company built two new vessels, *Washington* and *Hermann,* with side-lever engines constructed by Novelty.[70] These ships were followed in 1849-50 by four steamers constructed for the Collins Line, which was established by American entrepreneur Edward Knight Collins, to compete with the British Cunard Line. Two of the four Collins steamers, *Atlantic* and *Arctic,* received their machinery from the Novelty Works.[71] The loss of *Arctic* in 1854 was a major early American marine disaster. Among the passengers who lost their lives was the family of Edward Allen, a Novelty official and Horatio Allen's brother.[72]

Another fleet of steam packets was built in the late 1840s to run to and from Le Havre, France, including the *Arago, Franklin,* and *Humbolt,* all with Novelty-built engines.[73]

In 1847 Congress initiated another mail subsidy, which resulted in two steamship lines being organized for the Panama route. The mail, passengers, and a limited amount of light freight was carried by steamer from eastern U.S. ports to Panama. Passengers and cargo crossed the isthmus by rail and then by steamer to San Francisco. The government also subsidized the Pacific steamship lines. A group headed by William H. Aspinwall of New York organized the Pacific Mail Steamship Company to receive the mail contract for the Panama route, which soon grew in importance because of the discovery of gold in California. New York shipbuilders produced most of the liners for this route, and 22 out of 64 engines built there came from Novelty.[74]

Stillman, Allen & Company also provided machinery for *Adriatic* (350 ft. long, 50 ft. wide, and 5,000 tons displacement), when completed, the largest side-wheel steamer in the world except for Britain's *Great Eastern. Adriatic* was also considered the fastest steamship afloat for several years, once steaming 15 knots in smooth water. Her two oscillating engines had cylinders 101 inches in diameter with 12-foot strokes. The paddle-wheels were 40 feet in diameter and their hubs were probably the largest castings for steamships made in the United States before 1860.[75]

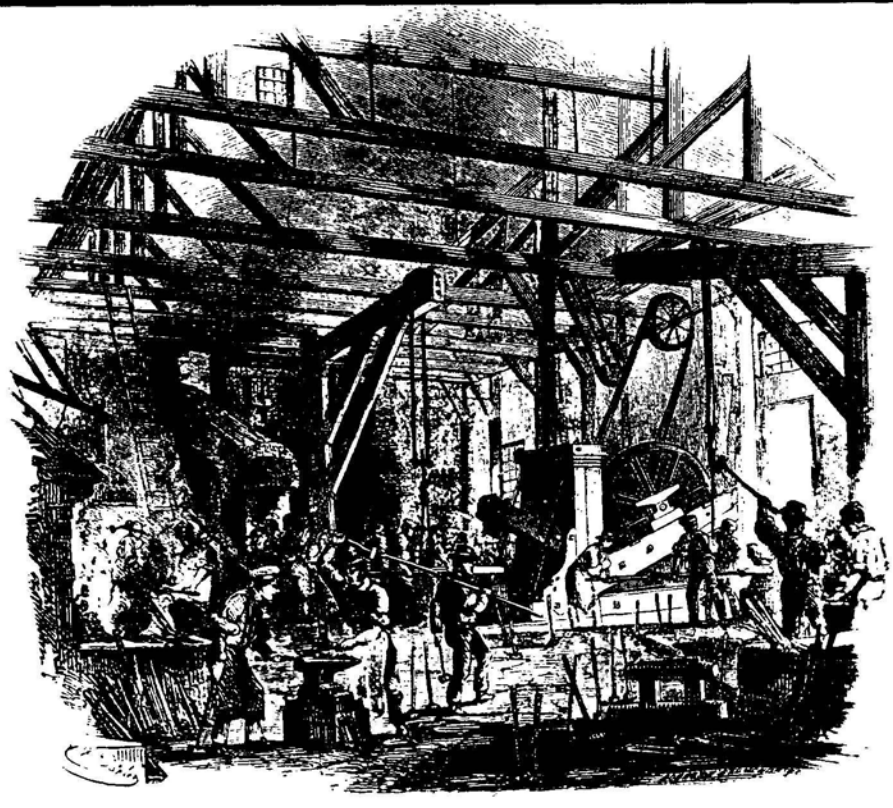
Unfortunately, *Adriatic's* machinery had major defects, primarily in the valves and valve-operating gear designed by Horatio Allen. Because of these deficiencies, the ship's maiden voyage was delayed more than a year, an expensive delay that was a factor in the failure of the Collins Line and would also seriously affect the prosperity of the Novelty Ironworks.[76]

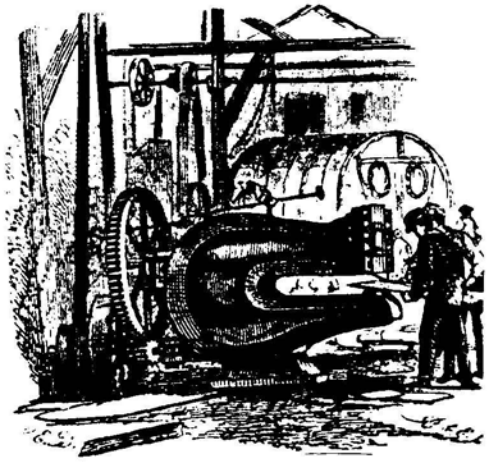
Novelty provided the machinery for a number of other pre-Civil War ships. *Nashville,* launched in 1853, had side-level engines. This vessel became a Confederate raider during the war and was destroyed in 1863.[77] In 1854 the Samuel S. Sneeden shipyard constructed the paddle wheeler *Metropolis* at Greenpoint, Long Island. Built for the Fall River Line, she was considered "the largest steamboat in the world."[78] In 1850 Novelty built the machinery for the Pacific Mail steamer, *Golden Gate,* and according to *The Scientific American* the wrought-iron center shaft and four cranks for this vessel were the "largest and heaviest pieces of wrought-iron mechanism ever made in this city, and, if we are not greatly in error, in this country."[79] *Golden Gate* was one of Pacific Mail's best steamers. The company also provided the machinery for a number of vessels built for other countries, including at least two for Russia and one each for Turkey and Brazil.[80]

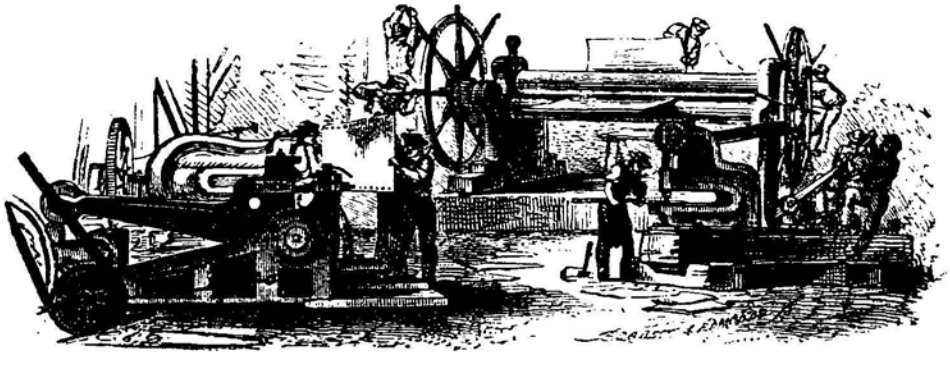
Novelty's lead in building the machinery for steamers was not the result of a clear superiority over the other constructors, nor cheaper prices, but rather the effect of Horatio Allen's personal and business ties with key individuals associated with various financial and shipping interests. For example, he was associated with William Henry Aspinwall in the Panama Railroad Company; Aspinwall was instrumental in developing the Pacific Mail Steamship Company. The Brown brothers' banking firm provided much of the financial backing for Pacific Mail, and Allen and the Novelty Works had a close relationship with Brown Brothers. In a suit adjudicated in 1856 involving Allen and the Novelty Ironworks, a lawyer stated that Edward Collins of the Collins Line was forced to use Novelty-built machinery in his vessels. "He was tied hand and foot by Brown Brothers & Company at the feet of Horatio Allen."[81]

Although Novelty's reputation rested to a great extent on the construction of marine machinery, the ironworks manufactured a variety of products ranging from sugar-mill machinery to fire engines. According to one account more than 75 steam fire engines designed by Lee & Larned were built by Novelty. "The fire Department of [New York City]...was completely equipped with them," Thomas Porter wrote.[82] In 1844 Novelty built two iron vessels for the government, one a surveying steamer, and the other a cutter for the Revenue Cutter Service.[83] Occasionally, the ironworks acted as the agent for products, including machinery, manufactured by other estalishments.[84]

Novelty's business fluctuated in the decade preceding the Civil War. The company expanded and prospered early in the decade because of the city's thriving shipbuilding industry. One authority estimated that Novelty's business in one year was worth more than 1.5 million dollars.[85] In 1850 the works stretched for nearly a thousand yards along the East River from 12th to 14th Street, and included an iron foundry with four furnaces, smith's shop, various buildings, and two slips capable of holding eight or 10 large vessels at one time. That year, 1,170 people were employed in the ironworks, but the steam power plant, the boiler factory, explosions from gasses in the molds







Workers at the Novelty Works mold and forge iron. (Harper's New Monthly Magazine, Vol. II, No. XII, May 1851)

combined with the billowing smoke from more than 30 forges in the blacksmith shop, created, according to one observer, an extremely noisy and smoky area.[86]

The city's shipbuilding business began declining in the mid-1850s. The high cost of construction, along with the failure of some of the large lines, particularly the Collins line, contributed to the decline. Whereas 37 steamers were launched in 1853 and 47 in 1854, only 13 were completed in 1855.[87] Novelty's business was hurt, not only because of the drop in shipbuilding activities but also because of the firm's well-publicized problems with the Collins liner *Adriatic.* The company's financial difficulties led to its reorganization in 1855. The new capital brought in by this reorganization stabilized the company's financial situation and more than likely saved it from collapsing during the country's economic crisis of the late 1850s.

Novelty, like so many industrial firms in the United States, was affected by the 1857 financial panic. A statement in an R. G. Dun report for September 1857 said, "Novelty works failed on Saturday;" but another report in October commented that "the Company will continue reliable...so long as they receive the support of Brown Brothers & Company under whose supervision the Company is conducted." An 1859 report stated that the "Company since its reorganization has had to contend [with]...strong opposition and a depressed condition of commerce and has consequently been obliged to take work at very low rates. It is supposed to have held its own." In 1860 R. G. Dun mentioned that the Company had had moderate business building fire engines and "work for the Russian Government." The report added that the firm had "made no money for some time," and "paid no dividends."[88] *The Scientific American* in its December 1860 issue agreed with Dun: "The Novelty Ironworks and the Morgan Ironworks are both working at present on short time, viz. nine hours, by reason of the financial embarrassment now obtaining in commercial circles and not from any lack of work."[89]

Less than three weeks before Fort Sumter was fired upon and President Abraham Lincoln's call for troops, Novelty was still not working to capacity. According to *The Scientific American,*

> At present they employ 600 men...there are now going forward two beam engines...for the Norwich and Stonington route; one marine beam engine...for the Pacific Mail Steamship Company; some quartz rock-crushing machinery for South America; an iron stern-wheel boat, fitted with two horizontal high-pressure engines and boilers; and hydraulic pumps and presses for a fish oil factory....Working time at present, nine hours per day.[90]

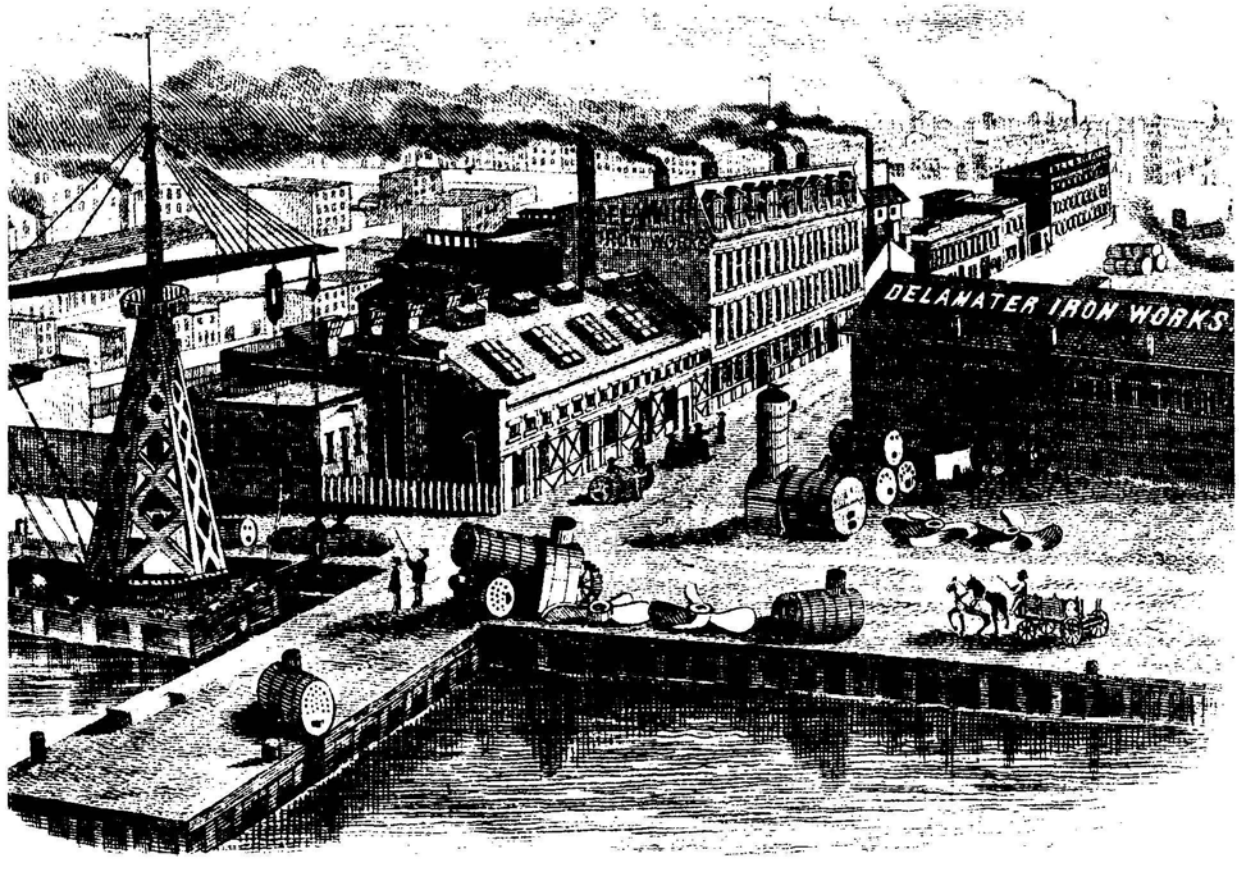
The war would change Novelty's condition, as it would other business firms throughout the country.

C. Delamater Ironworks

No New York City establishment profited more than the Delamater Ironworks, which built much of the *Monitor*'s machinery. Delamater, originally known as the Phoenix Foundry was established in 1835 by James Cunningham.[91] From the beginning, the company specialized in fabricating marine machinery, achieving some prominence because of a unique valve system that Cunningham developed. Cornelius Delamater joined the company at age 16 as a clerk. In 1842 the Phoenix works was purchased by Delamater and Peter Hogg, one of the foundry's draftsmen and engineers,[92] and the company's name was changed to Hogg & Delamater.

Three years before Delamater and Hogg assumed control of the ironworks, John Ericsson, a young Swedish inventor, contracted with Cunningham to do some work for him. Ericsson met Cornelius Delamater at the foundry, and a friendship and business relationship developed which would last throughout their lives. Delamater became Ericsson's closest friend. Ericsson constantly wrote to Cornelius , whom he called "Harry." "A happy new year to you my old and true friend," Ericsson wrote to "Harry" Delamater on January 2, 1868.[93]

Their business association was just as close. As one writer has pointed out, "rarely...did either of them enter upon a business venture without consulting the other."[94] After Delamater became sole owner of the foundry, Ericsson was never charged for using its facilities, tools, or materials. In return, Delamater was compensated when the Swede's inventions were successful. Ericsson preferred doing business through Delamater and permitted him to sell an unlimited number of his inventions. Cornelius Delamater "did more work for Captain Ericsson than any one else engaged in



Cornelius Delamater's association with John Ericsson lasted through much of his career. Delamater's ironworks profited from this association when it won the contract to construct Monitor's machinery. (Division of Mechanical and Civil Engineering, National Museum of American History, Washington, D.C.)

the line of engineering," said *The Scientific American* in Delamater's obituary. "It would have been unusual, almost unthinkable, for the Swedish-American engineer to have taken the [*Monitor*] work anywhere else. He had relied on Delamater almost exclusively since the firm agreed to handle the construction of two iron canal boats that were commissioned by Lieutenant Robert F. Stockton in 1839."[95]

Hogg & Delamater expanded substantially in the 1840s. Because of limited space at its original location, the company was moved to a new site in 1849, and the name changed to Hogg & Delamater Ironworks. A final name change occurred in 1858 when Hogg sold out to Delamater. The establishment until its demise would be known as the Cornelius H. Delamater Ironworks.[96] At the time the Civil War broke out, Delamater was reputed to be the largest marine steam-engine manufacturing establishment in the country.[97] It occupied "two hundred feet fronting the North River, with a front of six hundred feet on Thirteenth Street, and an equal space on Fourteenth Street as well as additional grounds on the south side of Thirteenth Street....The establishment is furnished with every requisite for building all kinds and varieties of machinery....There have at times been from one thousand to twelve hundred workmen employed here."[98]

J. Leander Bishop in his history of manufacturing wrote, "When the whole expense of conducting such Works is taken into account, it seems wonderful that such extensive operations should have been so successfully conducted under the proprietorship of a single individual." In contrast to the other large marine machinery works operated by partnerships or corporations, "the Delamater Ironworks have achieved distinguished triumph in engineering under the direction of a single proprietor possessing a mind of great executive and financial ability."[99]

An R. G. Dun report stated in 1854 that Delamater had "been doing a large business and made money, was considered rich." In 1857, the year of the financial panic, Dun mentioned that Delamater's business was "good and profitable."[100] The company apparently was not badly hurt by the recession that hit the country in the late 1850s.

As contracts were obtained, the company's work expanded form marine machinery to cast pipe and built machinery (boilers, engines, tanks, etc.) for sugar refineries and waterworks, fire engines, and stationary engines for a variety of uses, from running mill machines to fog horns. Delamater imported large tools from England and manufactured others. One of the most successful products was fire engines or Ericsson pumpers. Ericsson also invented a hot-air or "caloric" engine that was manufactured and sold in large numbers by Delamater.[101]

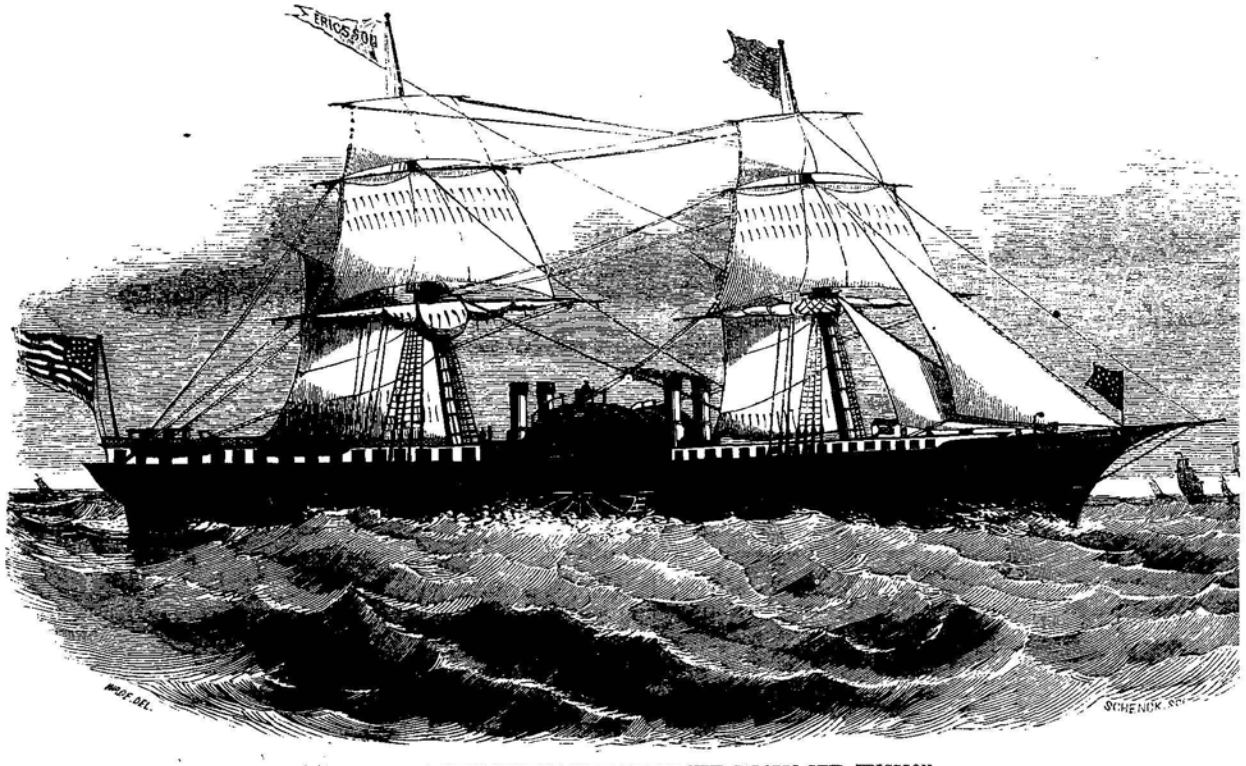
The company's reputation was built on marine machinery, particularly steam engines and propellers. Machinery was fabricated for paddle wheelers, but it was in propeller-driven craft that the company specialized, undoubtedly because of the unique relationship between Ericsson and Delamater. Even before Delamater became owner, however, the company was manufacturing the machinery for screw-propelled vessels. In 1837 Ericsson built a screw propelled steamer in England. Five years later, after having emigrated to the United States, he was employed by the Navy Department as superintendent for the construction of *Princeton*, the first screw-propelled warship. Although the hull and most of the machinery were built at Philadelphia, the Phoenix Foundry fabricated her boilers, propeller, and centrifugal blower.[102]

It is possible that *Clarion*, the first ocean-going propeller-driven craft in the United States, received her machinery from the Phoenix foundry. Originally a sailing vessel, she was converted to twin screws in 1840 by Ericsson.[103] In 1844, two steamers with screw propellers were launched, both with Hogg & Delamater-built machinery. *Midas* was a twin screw vessel built for Robert B. Forbes, a well-known shipmaster, shipowner, and strong advocate of propeller-driven craft.[104] She was followed by *Marmora*, also with Ericsson-designed, Hogg & Delamater-built machinery. From the mid-1840s through the Civil War, Hogg & Delamater dominated industry along the Atlantic coast in the construction of machinery for screw-propelled craft.[105]

Delamater benefitted from a close association with a yachting friend, Charles Henry Mallory, a Mystic shipbuilder and ship owner. Early in 1860 Mallory created a shipping company to run a line of steamers between New York and the Gulf ports. He built a number of wooden steamers and contracted with Delamater to provide their machinery, beginning a business association that would last for a number of years. As Mallory's biographer wrote, "For machinery, the Mallory yards depended primarily on the Delamater Ironworks,...the Reliance Machine Company, and the Mystic Ironworks. Delamater filled the bulk of Mallory's order for engines, boilers, shafts, pumps, and windlasses."[106]

In 1852 Ericsson designed a ship named after himself that was powered by a caloric engine, considered revolutionary by the inventor and many of his contemporaries. The vessel's machinery, which was as usual built by Hogg & Delamater, was designed to test Ericsson's idea of driving a ship by heated air instead of steam. Ericsson and Delamater also backed the ship financially, expecting it to be so successful that ship owners worldwide would adopt his caloric engine. In 1854 a Dun statement noted that Hogg & Delamater "have invested a large amount of money in the 'Ericsson ship experiment.' If it is successful they will be very rich, and if it is not, they will be hard run."[107] Ultimately, the ship's engines were considered a failure, the speed reaching only half of what was anticipated. Nevertheless, the company was not badly hurt financially, partly because John B. Kitching, a wealthy New Yorker and one of Ericsson's backers, absorbed much of the loss. Perhaps more important, the caloric engine proved quite successful for pumping water, driving printing presses, and running a variety of small machines, and in later years, Delamater built many such engines for non-marine use.[108]

Delamater also became involved in the constructon of iron vessels. As mentioned earlier two iron barges had been built for the Delaware and Raritan Canal Company in 1840. The works provided machinery for *Iron Witch*, launched in 1846, which was a side-wheeler built for the Hudson River and labelled by Dayton "a freak of the forties."[109] Although *Iron Witch* was a failure, two iron screw propellers built in 1859-60, *Matanzas* and *North Carolina*, were successful. *Matanzas* would be used in the West India trade until destroyed by fire in 1868. *North Carolina* would become a Confederate blockade runner during the Civil War.[110] Delamater had acquired considerable experience in



A VERY PERFECT VIEW OF THE NEW CALORIC SHIP, ERICSSON.

The caloric ship Ericsson was an early collaboration of John Ericsson and Cornelius Delameter. Delamater continued to manufacture caloric engines until well after the Civil War. (San Francisco Maritime National Historic Park)

fabricating machinery for iron-hulled vessels by the time *Monitor* was contracted for. The Clute Brothers Foundry had no such preparation.

D. Clute Brothers Foundry

In addition to the New York City firms, only one other establishment specializing in steam-engine construction was involved in building *Monitor*. In 1835 the firm of Clute & Bailey was started in Schenectady, New York, by P. I. Clute. Seven years later, Cadwallader C. Clute bought out Bailey and the firm became P. I. Clute and Sons.

In 1849 the elder Clute retired and Cadwallader C. Clute was joined by a brother to form Clute Brothers. The establishment was continued under that name for more than 30 years. The foundry manufactured tools, boilers, steam and caloric engines, both stationary and marine.[111] Machinery was built for Erie Canal boats. Little is known about the company's business activities until the

1850s when it started building Ericsson's caloric engines, which was probably why the establishment was chosen as one of the *Monitor* sub-contractors.[112]

E. Continental Ironworks

Continental Ironworks was the most recently established firm that contributed to the building of *Monitor*. Thomas Fitch Rowland was the company's owner in 1861. Rowland was born in New Haven, Connecticut, in 1831.[113] At age 13 he began work in his father's grist mill, and a few years later was employed in the machine shop of the New York and New Haven Railroad. He first became involved in the maritime industries in 1850, when he was appointed an engineer on the steamboat *Connecticut*. Two years later he obtained a position with the Allaire Ironworks, one of the largest builders of marine-steam machinery in New York City. Rowland worked for four years in the machine shop and drawing room and then was appointed superintendent. He supervised the construction and installation of machinery for several vessels, including *Harriet Lane*, before leaving Allaire to join Samuel Sneeden's shipyard as engineer. Sneeden's shipyard, located in Brooklyn, specialized in the construction of small wooden vessels. In 1859 Sneeden contracted to build an iron steamer for a New Orleans businessman to run on Lake Pontchartrain. He had no experience in iron-ship construction, and hired Rowland as his engineer and superintendent. Rowland designed the ship, including her hull, "constructed in the same manner, substantially, as a steam boiler, with a single thickness of plates of iron riveted together where they lap at the edges."[114]

Thomas Fitch Rowland, 31 years old and "full of energy and enterprise," actively campaigned to win government contracts for iron work when the Civil War began. Rowland's efforts were rewarded when he was selected to build Monitor's hull.

Rowland and Sneeden's subsequent relationship is unclear, as is the origins of the Continental Ironworks. One account says that Rowland, in association with Sneeden, established a business at Greenpoint; another states that he took over the Sneeden shipyard in April 1859. Fred Irving Dayton, however, mentions Sneeden and Rowland as partners in 1861. A fourth source refers to the two as partners in the Continental Ironworks, "a concern which did other types of iron construction."[115] The most logical explanation is that Sneeden and Rowland became partners some time after Rowland joined the firm and continued the association until 1861. In 1860, they created the Continental Ironworks, which absorbed the old shipyard. Their first important contract, with the New York Water Board, was to construct "a wrought [iron] tube seven and a half feet in diameter and one and a quarter mile in length to be connected to a bridge over the Harlem river," linking the Croton Aqueduct to a reservoir in Central Park.[116]

The partners received a contract in 1861 to build two steamboats for the Norwich & New York Transportation Company. The first one, *City of Boston*, was launched in 1861, and the second, *City of New York*, the following year. They were large vessels, more than 300 feet in length, and according to J. Scott Russell, who was a well-known English naval architect and designer of *Great Eastern*, were "remarkable specimens of American naval architecture."[117]

III. Civil War Contracts

By the time *City of New York* was completed, the Civil War was in its second year, and the Continental Ironworks and other *Monitor* companies were deeply involved in government work. Novelty Ironworks was the first of these companies to receive a contract. The Navy's engineer-in-chief, Benjamin F. Isherwood, had worked at Novelty early in his career and regarded the firm highly. Shortly before the Civil War Isherwood designed the machinery for two Russian gunboats that were constructed at Novelty under his direction.[118] Shortly after the conflict began, the Navy decided to build small wooden gunboats that could be used for close inshore work in the shallow Southern waters. Isherwood recommended that the Russian gunboat design be adopted, and that Novelty be awarded a contract to build them. The Navy agreed, and the New York City firm received a contract to build the machinery for four of the gunboats. They were completed in 90 days, earning for that class of vessels the name "ninety-day gunboats."[119]

Throughout the summer and early fall of 1861, Novelty was occupied with the gunboats and machinery for several steamers, including the Pacific Mail steamship *Constitution*.[120] Novelty company sought no additional government work until Ericsson approached the company with the proposition to construct *Monitor's* turret. R. G. Dun reported in October 1861, that "they [Novelty] have recently had increased work and employed a good many hands,"[121] presumably, a result of the *Monitor* work, which had started that month.

Novelty's neighbor on the East River, the Cornelius Delamater Ironworks, spent the early months of the war completing the steamships for Mallory. In July 1861, Delamater journeyed to Washington, D.C., where he conferred with Secretary of the Navy Gideon Welles. Delamater informed Ericsson, "I am treated well...yet I have no expectation of any contract or immediate good to result to me or to us..."[122] According to a history of the company, Delamater offered the government "such work as might be needed, but nothing was forthcoming until the *Monitor*."[123] Continental Ironworks on Long Island and its owner, Thomas Rowland, faired better. Rowland (31 years old) was "full of energy and enterprise, anxious to identify himself with government work." As soon as the war started, Rowland endeavored to obtain government contracts. He was awarded one by the Navy to build gun carriages and became a sub-contractor to manufacture wrought-iron beds for 13-inch mortars, which were later installed on schooners and used by David Dixon Porter in an attack against the forts guarding New Orleans. The Navy also engaged the company to fit out merchant vessels purchased for war service.[124]

In May 1861, Rowland travelled to Washington with a model and proposal for an ironclad warship. The proposed vessel was to be a twin-screw ironclad of about 750 tons, armored with three layers of one-and-a-fourth-inch iron, backed by iron bars laid parallel to each other. Two diamond-shaped "gun houses" were initially planned, but in a modified proposal submitted later they were replaced by two revolving turrets. A board of naval officers considering various proposals rejected Rowland's, saying, "it would not bear the weight and provide stability."[125]

The proposal had been signed by Charles W. Whitney and Rowland. Whitney was the New York agent for H. Abbott & Sons of Baltimore, who may well have agreed to provide the iron plating for the vessel. Rowland withdrew from the project after the board's rejection, but Whitney later got a contract for constructing an armored vessel that was named *Keokut*. It has been suggested that it was after Rowland's proposal was turned down that he agreed to sub-contract for *Monitor's* hull.[126]

John F. Winslow, representing the Albany and Rensselaer Ironworks of Troy, also hurried to Washington eager to secure war contracts. In September 1861, he wrote, "we have...propositions before the War and Navy Departments, and with attention, we shall secure a fair proportion of what is wanted." Winslow, as Ericsson would later recognize, was well connected in Washington. He was a political ally of Secretary of State William Henry Seward and New York Representative Erastus Corning. Winslow contracted with the War Department to furnish railroad equipment and even a few cannon.[127] Two experimental rifled guns were cast out of steel, or what *The Scientific American* called "semi-steel." Although the magazine claimed that the firing tests conducted at West Point were successful, apparently no contracts for additional guns were awarded to the Troy works.[128]

Winslow and his Troy partner, John Griswold, were approached by Cornelius Bushnell, a New Haven, Connecticut, businessman, to provide iron for an armored warship that he was proposing

to build. Bushnell's vessel, named *Galena*, would receive her iron, including armor plate, from the two Troy establishments. Winslow devised a system of plating, which he patented, that was applied to *Galena*. In order to eliminate the use of bolts to attach the plate to the wood backing, which he considered to be a serious weakness of European ironclads, he developed a "tongue and groove" system, with the plates being attached by rivets to iron "chairs" similar to inverted railroad T-rails.[129] *Galena*—and Winslow's armor plan—was a failure. The ironclad was badly damaged, with at least 18 shots penetrating her armor, when she engaged Confederate forts near Richmond in May 1862. As a result of the business relationship with Bushnell, Winslow and Griswold later became involved in the *Monitor* project.

Undoubtedly other *Monitor* companies sought government contracts. Certainly H. Abbott & Sons did. The firm's size, capabilities, reputation, and proximity to the nation's capital made it a prime industry to secure government work. Undoubtedly Holdane & Company sought similar contracts. R. G. Dunn reported in the spring of 1862 that Holdane was "done good business and made money since the Rebellion broke out."[130] There is no evidence that Clute in Schenectady, nor the Niagara Steam Forge Company in Buffalo engaged in government work before becoming *Monitor* subcontractors. According to a recent study of Buffalo, "The Civil War [did]...little to alter the commercial orientation of Buffalo's economy...Those industries that did exist at the end of the war—iron foundries, ship builders, clothing manufacturers—produced strictly for the local market."[131]

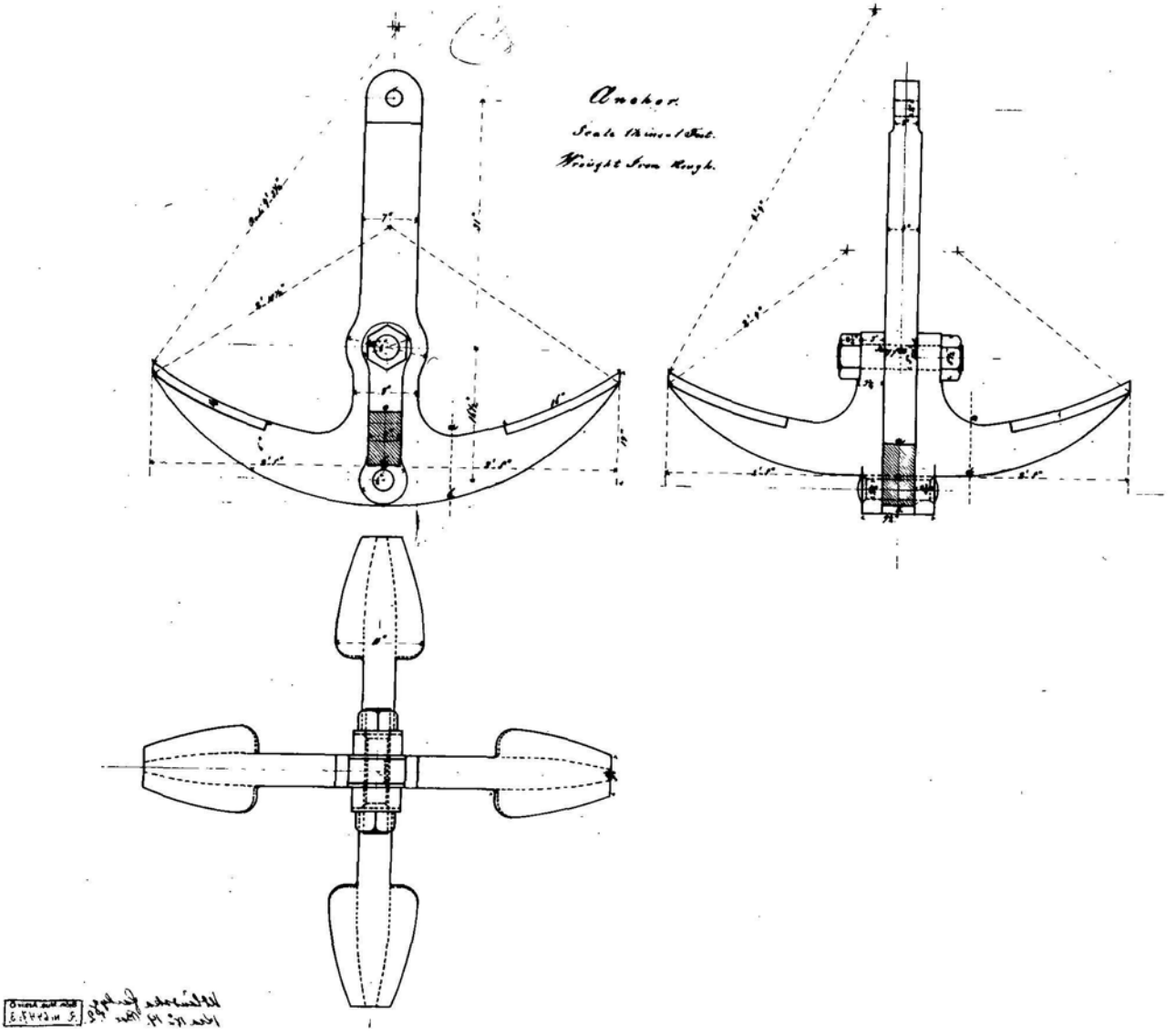
The story of *Monitor's* construction and the contribution by the various companies has frequently been told, and need only be briefly mentioned here.[132] Ericsson, Bushnell, Griswold, and Winslow were all instrumental in getting the proposal for "Ericsson's battery" accepted by the Navy, and a contract was awarded to the "Battery Associates" on October 4, 1861. Each of the four took a fourth interest in the venture. Initial financial backing was obtained by Griswold and Winslow.[133] Because of the contractural time constraint of 100 days to complete the ironclad, the contractors decided to subdivide the work among a number of establishments. They also divided up their responsibilities. Griswold would handle finances; Winslow would obtain the iron including the armor plate; and Ericsson would see that the machinery was built and oversee the vessel's construction.[134]

Ericsson and the contractors for the hull and turret provided Winslow with specifications, drawings and amount of iron needed, and he in turn either produced it at the Troy facilities or ordered it from H. Abbott & Sons or Holdane & Company. The Troy works manufactured some of the angle and bar iron, spikes, and bolts, but because of other commitments, particularly *Galena*, Winslow had to depend on the other ironworks for much of the iron. Ericsson wanted rolled plates of 4-inch thickness for the armor, but Abbott, the only establishment in the country capable of manufacturing them, said that it would take at least two months to modify their facilities to roll iron of that thickness. The Navy reluctantly agreed to accept one-inch plate for laminated armor.[135] Abbott and the Albany Ironworks manufactured the armor plate, which was the first rolled in the United States.[136]

Holdane & Company was not a manufacturer, but an iron dealer in New York City. The firm contracted to provide a large quantity of angle iron for frames, bulkheads, and more, along with 125 tons of armor plate. Apparently Holdane had difficulty in supplying it. On November 12, Ericsson wrote to Griswold complaining about the non-receipt of iron from Holdane: "The ½ inch engine bulkhead iron Mr. Holdane has been promising from day to day—not a sheet had made its appearance yesterday." He added, "I feel sometimes a despair on account of the want of material." In a postscript he wrote, "Mr. H. has also at last given me the names of the parties who manufactured the iron." Earlier he had mentioned that "strange to say I am not permitted to know where the plate is being rolled."[137]

Ericsson negotiated for the machinery and for the construction of the turret and vessel itself. Delamater, not surprisingly, was to manufacture the main engines, boilers, propeller, and other machinery parts. He contacted Clute & Brothers, a firm with which he was familiar because of their success in producing his caloric engines. On November 6, he accepted an offer from Clute to build the turret engines, gun carriages, anchor hoister (windlass), and engine room grates.[138]

Ericsson selected the Novelty Ironworks to construct the turret because it was apparently the only establishment in New York City with powerful steam-operated presses and other facilities needed to bend the iron plates. The Continental Ironworks was chosen to actually build the vessel.[139] Ericsson



John Ericsson produced engineering and construction drawings almost daily to guide the casting and assembly of Monitor. The distinctive four-fluke anchor shown here was one of many new features manufactured to Ericsson's specifications. (National Museum of American History)

never said why that company was selected. He wrote in an account of *Monitor*, published after the war, that "I divided the work among three leading mechanical establishments," presumably referring to Novelty, Delamater, and Continental.[140] Geographical proximity may have been a factor in the choice. "All three were readily accessible for the engineer to personally supervise and direct the activities at each location. As the three major elements of the battery were to be constructed separately, Ericsson felt that their successful assimilation would depend heavily upon his maximum supervision and coordination."[141]

Undoubtedly their relative closeness was an attractive feature, but more important were Rowland's experience in building iron vessels and the facilities available at Continental. As one writer noted, "Rowland's experience and shipbuilding facilities were well suited to Ericsson's needs."[142] According to Church, Rowland approached Ericsson about it. Of course, the shipbuilder was well known to the inventor, and his yard was a logical site to construct and launch *Monitor*.

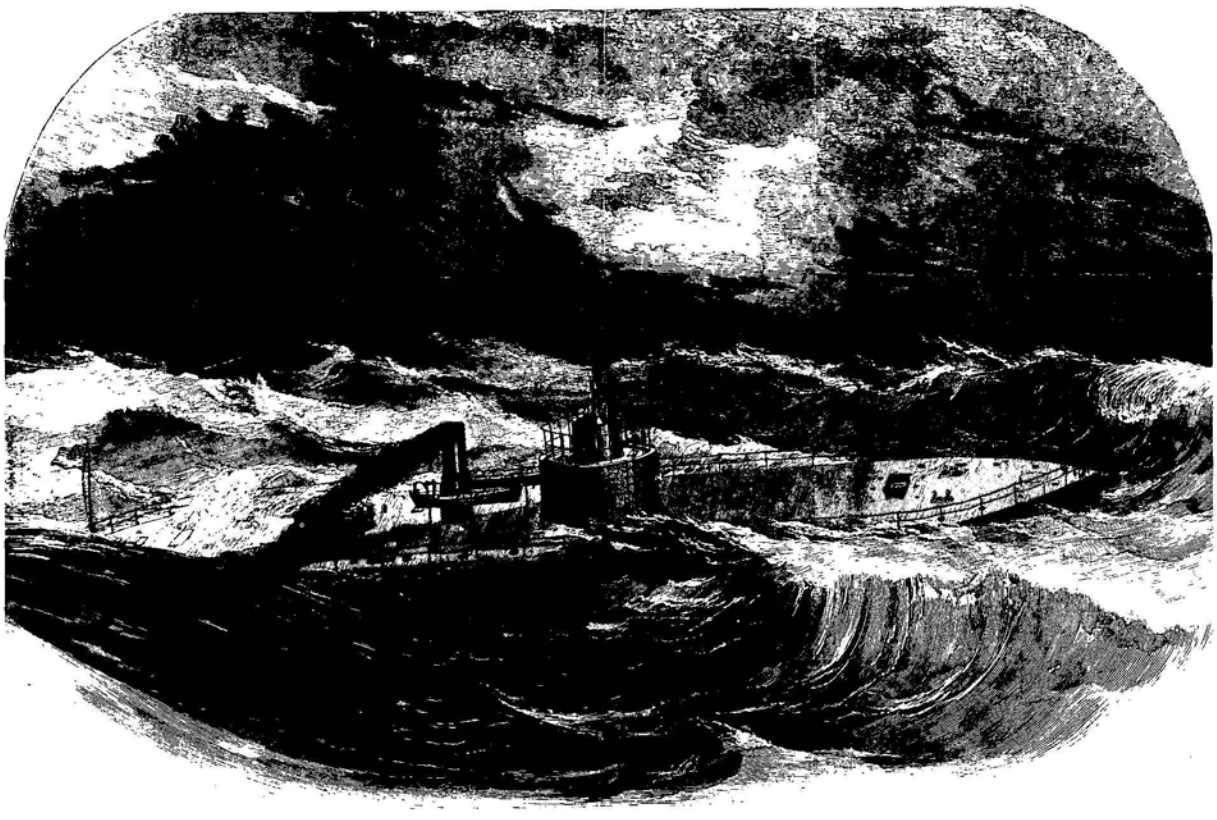
Monitor was completed early in 1862, and after sea trials in February left under tow March 6 to join the blockading squadrons. The warship arrived in Hampton Roads in time to challenge the Confederate ironclad *Virginia* in one of the more dramatic naval engagements in American history. *Monitor's* apparent success in the battle produced such intense enthusiasm in the North that a "Monitor" craze swept the Union. Three weeks after the action, 10 improved Ericsson monitors were contracted, the *Passaic* class, which would see more service than any other class of monitor. Until the end of the war the Navy would concentrate on monitor construction. Of the 40 armored vessels laid down by the Union during the war, 35 were of the monitor type.

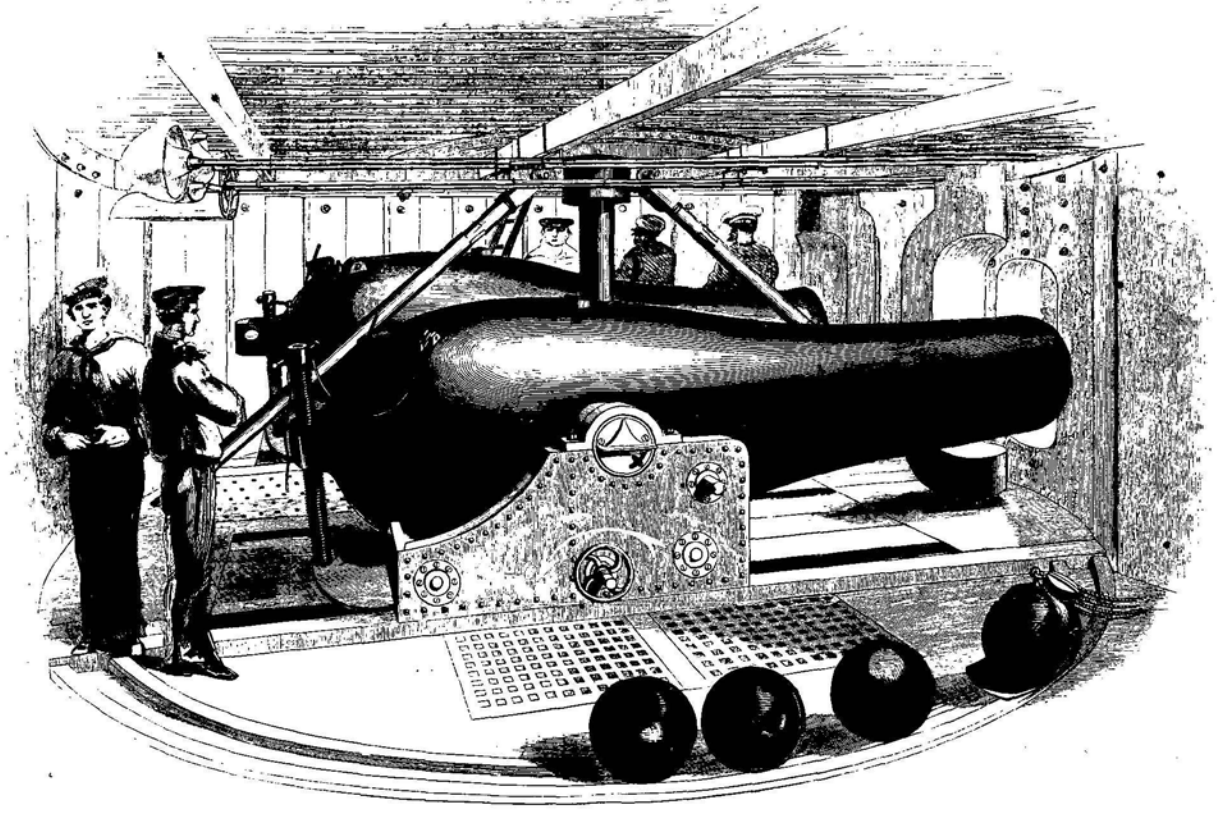
Ericsson profited from this situation not only in the acclaim for his design but in the award of contracts to construct six of the improved monitors. He immediately subcontracted with several of the same firms that built *Monitor*.[143] Continental Ironworks constructed the hulls and turrets for three, *Passaic, Montauk,* and *Catskill*. Delamater provided much of the machinery. As with *Monitor*, the Troy interests handled the finances. On March 14, 1862, six days after the Hampton Roads action, Winslow wrote Corning, "We have closed for 6 Boats on the plan of the *Monitor* for $400,000 each—they are to be a trifle larger in size—this will do."[144]

The armor plate was supplied by Abbott & Sons. Possibly other ironworks, including those in Troy, provided some of it, although it is more likely that the New York firms furnished the other iron materials.[145] Evidently Clute was a subcontractor again. Correspondence in the Ericsson papers located in the New York Historical Society and the American Swedish Historical Foundation between the inventor and the Schenectady works concerns blowers and other miscellaneous parts, but specific vessels are not mentioned. In November 1862, Clute Brothers wrote Captain Albin C. Stimers, who had been appointed "General Inspector of Iron Clad Steamers," concerning a contract to provide turrets for a later class of monitors. In the letter the company asked "if the drawings for Gun Carriages for 11-inch guns which we examined at Capt. Ericsson's are the ones to be used." Clute Brothers definitely received a contract to build the anchor-hoister machinery for the sea-going monitor *Dictator*.[146]

In addition to *Passaic*, Ericsson received a contract for two large oceangoing monitors that were named *Dictator* and *Puritan*. *Dictator's* hull and machinery were subcontracted to Delamater. *Dictator* was commissioned in November 1864, but mechanical difficulties prevented her from participating in the final naval operations of the war. *Puritan's* hull was subcontracted to Continental Ironworks, and, although launched in 1864, was never commissioned.[147] Secretary of the Navy Welles wrote in his diary that "the contractors for the *Puritan* and the *Dictator* are in trouble and embarrassed," apparently because they were unable to meet their schedule for completing the vessels. Nevertheless, the Secretary recommended that they be fully paid to keep them from being ruined.[148]

Thomas Rowland, the young and energetic president of Continental Ironworks, secured a substantial amount of work for his establishment during the war. Ericsson was clearly pleased with Continental's work on *Monitor*, awarding the firm contracts to build not only the hulls and turrets for three "improved monitors," (*Passaic, Montauk,* and *Catskill*), but the turrets of three others (*Sangamon, Lehigh,* and *Patapsco*). The company would later receive a contract to build the hull and turrets for *Onondaiga*, the first double-turreted monitor, and finally an agreement to construct the "light-draft" monitor *Cohoes*.[149]

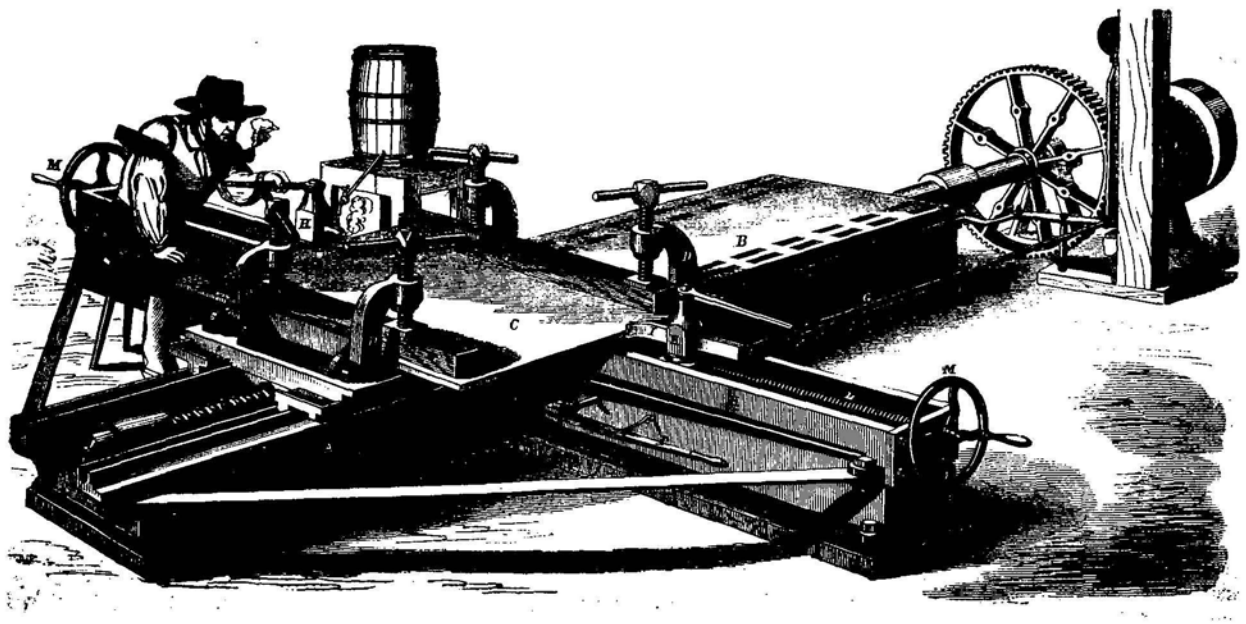




Many of the firms that built Monitor received contracts to construct the next generation of monitors. Passaic, shown here, was first of a type built largely by both the Continental and Delamater Ironworks. (Harper's Weekly, Vol VI, No. 310, December 6, 1862)

Continental's substantial turret contracts resulted in Rowland's designing and building special machinery, including a "double planer for armor and turret plates" described in *The Scientific American*. In another issue the editor reported on another unique piece of turret machinery developed by Rowland: "the holes [on the plates]...are...drilled out by means of an ordinary drilling machine, ingeniously arranged upon a long piece of timber, and operated by a small engine. This timber has a bearing in its center, which works around a central shaft in the turret, and by this arrangement all the holes are easily run through, first with a drill, and then finished with a reamer. The use of this machine despenses with the labor of no less than seventy-five men; it was not employed in the construction of the *Monitor*." An article in *Harper's New Monthly Magazine* mentioned that Continental was heating plates before bending them, "so the powerful hydraulic press [used by Novelty] is despensed with."[150]

Rowland impressed not only Ericsson but all those who visited his plant. A writer for *Harper's New Monthly Magazine* admired his administrative skills and energy. *The Scientific American's* editor called him "ubiquitous." "He is inquired for on every side, overseeing the most minute details, he seems to accomplish in his own person the work of two of three men."[151] The Navy, however, was not as complimentary. On the basis of a report from Rear Admiral Francis H. Gregory, head of the "Monitor Bureau," Secretary Welles wrote on September 26, 1862, "Mr. Rowland, the contractor, seems to have great responsibility and he ought to throw his whole energies into the work, giving daily the influence of his presence among the workmen, especially in the case of *Catskill* so far behind."[152]



Continental Ironworks' many monitor contracts resulted in Thomas Fitch Rowland's design and construction of this "double planer for armor and turret plates," one of many inventions inspired by the need for a new "ironclad" technology. (Scientific American, Vol. VII, October 25, 1862)

By the fall of 1862, Continental Ironworks occupied seven to eight acres; according to *The Scientific American,* it was so crowded with buildings, shops, stacks of lumber, iron, etc., that "locomotion [by the workers] is both difficult and dangerous." The number of workmen employed by Rowland varied from 500 to more than a thousand during the war.[153]

In September 1862, *The Scientific American* boasted of the "immense ironclad fleet in the course of construction" in New York City. The city had been a center of shipbuilding for many years, yet the local papers were aware that more warships, particularly the new monitor types, were being built in their community than elsewhere in the country. The evidence was visible, including the prosperity that it engendered. On March 17, 1863, the Brooklyn *Union* reported on the "unabated prosperity of the ship building interest in that Long Island city." The value of the number of warships and commercial vessels under construction "was upward of ten millions of dollars, and the number of persons employed thereon is between two and three thousand."

Not all were pleased with New York City's good fortune. Charles H. Cramp, who owned extensive shipbuilding facilities in Philadelphia, wrote in his memoirs of a New York "ring" presumably involving Admiral Gregory and other naval officers responsible for warship construction in the country, as well as influential civilians. He accused the "ring" of preventing "the construction of a type of iron clad vessel except monitors," and of concentrating warship construction, especially armored vessels, in New York City.[154] Ericsson did favor New York and Boston contractors, but it is equally true that New York City along with Philadelphia were the nation's center for iron-ship construction before the war.[155] The New York interests, particularly Ericsson, also had political support in Washington. During the first year of the war Erastus Corning had represented one New York district until replaced by Griswold, who was eventually appointed to the Naval Affairs Committee. The business relationship between Ericsson and Griswold, which began with the *Monitor* negotiations, continued throughout the war. "Griswold acted as Ericsson's Washington agent and spent much time in the Navy Department promoting the inventor's interests whenever possible."[156] Nevertheless, there is no evidence that a New York ring existed. Of the 27 monitors contracted before 1863, 20 were built outside New York City, and naval officers in Washington, particularly Assistant Secretary of the Navy Captain Gustavus Fox, were most responsible for concentrating on the monitor type.

The monitor companies understandably did not depend entirely on Ericsson for government contractual work. Continental Ironworks built the hull and machinery for the iron side-wheeler *Muscoota;* Delamater and Clute Brothers provided miscellaneous machinery parts for a number of Union vessels other than monitors; and Abbott & Son rolled plate for the majority of armored vessels built in the Northern states.[157]

Abbott received a contract from the War Department shortly after completing *Monitor's* plate to fabricate 30 mortar beds for use on Western rivers. Abbott also manufactured mortar beds for David Dixon Porter's flotilla that bombarded the forts guarding New Orleans. In 1863 Abbott completed another order for 250,000 pounds of rolled iron in 48 hours and received a letter of commendation from the Secretary of the Navy for this achievement.[158]

There is no evidence that the Niagara Steam Forge subcontracted with Ericsson or solicited additional government work after *Monitor.* Despite its geographical isolation from the Eastern seaboard and the mainstream of war-related activities, Buffalo's economy expanded during the conflict. By 1865, for example, the city had 20 ironworks in operation. Most of this prosperity, however, was related to the Great Lakes. Shipbuilding on the Lakes boomed during the war years, and Buffalo was a center of the industry. The first commercial iron ship, *The Merchant,* was built in 1861 in Buffalo. The Niagara Steam Forge made the engine shafts and other parts for many of the new vessels, and by 1865 employed 120 workers.[159]

Novelty Ironworks, which built *Monitor's* turret, was the only major subcontractor to no longer work for Ericsson. This was probably because the company was already working on an armored vessel, *Roanoke,* when the contracts for the "improved monitors" and the ocean-going monitors were let. *Roanoke* had been built before the war as a large screw frigate, a sister ship of the *Merrimack.* The Navy decided to convert her into an ironclad by cutting the hull down to the gun deck and then plating her with iron armor. It was proposed that she carry four Coles turrets on the center line, but, because of the weight, only three were installed. According to one account, Novelty was selected as the builder, "as no Navy yard could produce...heavy armor."[160] Novelty

received a contract to provide the iron plate and to build the turrets probably in March 1862, and she was completed and placed in commission approximately a year later.

Roanoke's plate was rolled at another New York ironworks, and transported to Novelty where it was drilled and "curved" by using a large hydraulic press.[161] Although *Roanoke* was theoretically the most powerful turreted vessel commissioned during the war, she was generally considered a failure. The weight of the three turrets caused her to roll heavily, even in a slight seaway; her hull was too weak to support them; and her draft was too great to operate in the shallow Southern waters. She joined the North Atlantic Blockading Squadron for several months, but spent most of her service as a station or guard ship.

Roanoke's completion did not result in Novelty's working with Ericsson again, possibly because of other commitments, or because of the use of Coles turrets on *Roanoke*, or possibly because of Horatio Allen's strong ties with two influential naval officers, Alban C. Stimers and Benjamin F. Isherwood, both of whom frequently clashed with Ericsson. Navy Chief Engineer Stimers, who was Inspector General of Ironclads with an office in New York City, even hired a Novelty engineer, Allen's nephew, as his assistant.[162]

Allen's relationship with Isherwood, who was Engineer-in-Chief of the Navy, was much closer. Isherwood had served as an apprentice at Novelty in the 1840s and had been instrumental in obtaining for Novelty the contracts to build the ninety-day gunboats and *Roanoke*. In 1863 Isherwood persuaded the Navy Department to sponsor an investigation of the "value of working steam expansively" with an appropriation from Congress. Chief Engineer Stimer chose Allen to conduct the experiments, which were carried out at Novelty.[163]

Finally, Novelty built Isherwood-designed machinery for two warships, the monitor *Miantonomoh*, and the screw steamer *Wampanoag*. *Miantonomoh* was one of four large, double turreted monitors, two with Ericsson-designed machinery and two Isherwood's. After the war *Miantonomoh* would be the first monitor type to cross the Atlantic Ocean. *Wampanoag*, called "Isherwood's masterpiece" was designed to challenge the Confederate cruisers. Carrying Isherwood-designed machinery, Novelty-built, she was remarkably fast, making the record-breaking speed of 17.75 knots on one trial run. She had been laid down in 1863 but not completed until four years later.[164] Allen's relationship with the Navy Department, especially Isherwood, clearly benefited Novelty. In addition to the various vessels mentioned above, the company built machinery for seven additional warships during the conflict.[165]

Novelty also had the time to build the machinery for two large sea-going amored warships constructed in New York City for the Italian government, several commercial steamers, and even a yacht. Finally, the ironworks continued to manufacture machinery for domestic use, such as paper mills.[166]

In June 1862, R. G. Dun & Co. recorded in a ledger that Novelty has "had considerable good work...& have now a contract for iron plating of war steamers." Ten months later *The Scientific American* reported that "at these works we found a large number of engines in all stages of construction." Nine hundred workers were employed according to the magazine. A year later the company was still heavily involved in marine steam-machinery building. Four beam and two single-screw engines for Pacific Mail steamers under construction in New York City, engines and boilers for two revenue cutters, as well as the machinery for the naval vessels, were all in various degrees of construction. Novelty would be busy throughout the war and, according to R. G. Dun "made money fast."[167]

Novelty was not the only *Monitor* company during the war to be involved in both government and non-government work. Delamater continued to build machinery for commercial vessels throughout the conflict. Several engines were constructed for Lake Erie vessels; machinery for a number of vessels engaged in New York and New England coastal and inland trade, and machinery for several vessels, "taken into government service," was produced by the firm. Delamater's business relationship with Mallory, developed before the war, continued with the New York establishment's supplying engine's and machinery for the hulls built by the Mystic shipbuilding firm. By the middle of 1863 Delamater was employing nearly a thousand men.[168] Like Novelty, Delamater made money during the war.

The Civil War, in fact, benefited all the *Monitor* companies, as it did other firms in the country, enabling them to recover from a period of instability that beset the nation's economy in the years before the war. The wartime reports of R. G. Dun & Co. clearly indicate the companies' prosperity. However, the end of the war brought changes. Demobilization, an increasingly parsimonious Congress and what one authority has referred to as "the naval establishment's resistance to technological change" resulted in a drastic decline in warship construction.[169]

There was an equal decline in merchant-ship construction. This deterioration actually began before the war as American shipbuilders were unable to compete with the heavily subsidized British companies. The Civil War decimated the American carrying trade. Finally, in the post-war years, British competition once more hurt the American shipbuilding industry, particularly in the construction of iron ships.[170] To make matters worse, the government sold off hundreds of old blockaders, transports, and captured vessels.

IV. Post-War History

Two years after the war, ship construction in New York City was virtually at a standstill. Novelty was completing *Wampanoag* and several other vessels, but there was only one merchant vessel on the stocks of the 13 shipyards in New York City, Brooklyn, and Jersey City. When that ship was completed in the summer of 1868, it marked the end of New York's quarter-century of leadership in the building of ocean going steamships.[171] Shipbuilding in the area would be limited to river, harbor, and coastal vessels. U.S. Census Agent Henry Hall in his shipbuilding industry report published in 1882 said, "Since the war it has not been practicable to carry on iron-shipbuilding in New York City...the building of hulls...has ceased, prices, wages and taxes being too high for that class of work."[171]

The *Monitor* companies were affected by the shipbuilding industry collapse. Novelty completed work on the machinery for the Pacific Mail steamers *Arizona* and *Great Republic* in 1866 and *Wampanoag* in 1867. Although Pacific Mail Steamship Company made a loan of $500,000 to keep the company operating, it closed down in 1870. R. G. Dun mentions, "the concern belonging to James Brown of Brown Brothers & Co., who are about closing it all up, trying now to dispose of it. The business has not been lucrative for some time past and are under very heavy expenses."[173] The valuable property along the waterfront was sold to a gas company.

Horatio Allen, the company president for so many years, retired in 1871. Nevertheless, he came out of retirement for one more prominent engineering project, the construction of the Brooklyn Bridge. Although he knew little about building a suspension bridge, he served for three years as senior consulting engineer. He apparently did very little; the bulk of the work in designing and building fell to John A. Roebling. Allen retired a second time and as a prominent New Yorker was involved in civil activities for many years.[171] He died in 1889, at age 87.

Cornelius H. Delamater died that same year. Unlike Novelty, Delamater's ironworks were still in existence at his death, Also, unlike Allen, Delamater was able to continue a profitable business in the construction and repair of machinery for many years after the war, partly because of the unusually strong business relationships between Delamater and his associates, Ericsson and Mallory. In 1869 the ironworks received a contract to build and install the machinery for 30 small gunboats for the Spanish government to be used in Cuban waters. Half the hulls were built by Mallory in Mystic, Connecticut, the remainder elsewhere; those gunboats had been designed by Ericsson.[175]

Delamater built the machinery for several steamships including *City of Merida* and *Fern*. Because of Ericksson's influence with Delamater, the company periodically sought government contracts, but with little success. Ericsson designed a torpedo boat that he named *Destroyer*, built at Delamater and financed partially by the firm. Although a number of successful trials were carried out, the Navy never showed much interest.[176]

While *Destroyer* was being built and tested, a submarine was constructed in another part of the plant. Designed by John P. Holland, she was built in secrecy for Irish revolutionaries. The "Fenian Ram," as the submarine was called, never made it to Ireland, but was towed to Connecticut, and evidently later sold for scrap.[177]

Delamater's non-marine business was prosperous thoughout the year. Large numbers of Ericsson's caloric engine, as well as a hot-air pumping engine designed by one of the firm's engineers, were sold. In the 1870s the company did considerable ironwork for the elevated railroad under construction in New York City. In 1871 a steam-powered drill for use in mines was produced, and later air compressors were manufactured. In the early 1880s the company began to build and sell refrigerated ice machinery. Despite the company's success, when Cornelius Delamater died in 1889, his son sold the business the following year.[178]

Continental Ironworks, which had acquired a reputation as a builder of iron steamers and armored vessels, rebuilt one monitor, *Monadnock*, after the war. The company also constructed two iron ferries, *Fulton* and *Farragut*, for the Union Ferry Company; the steamer *Nanking* for the China trade; several steamboats for Cuban waters, and 50 surfboats for the U.S. Lifesaving Service. Continental's marine work virtually ended by the mid-1870s. Nevertheless, a story in the *Nautical Gazette* mentioned that "these works [were]...capable in every respect for the construction of iron and composite vessels of every description, revolving turrets, armor plate, [and] gun carriages."[179]

After the Civil War, Delamater Ironworks continued an active and profitable business. One product of the yard was John P. Holland's Fenian Ram, a prototypical submarine, inspiration for modern underwater warfare, and a vessel as revolutionary as Ericsson's Monitor.

Thomas Rowland, the firm's owner, also began to design and manufacture steam engines and boilers especially adapted for use in the oil industry and gas works. Continental constructed the gas works for Brooklyn in 1867, followed by similar plants throughout the country. Rowland experimented in iron and steel welding, and in the late 1880s designed the process and the equipment used by his company in the manufacture of corrugated furnaces and "Morison suspension furnaces," widely used for many years in the internal furnace type of boiler.[180] Rowland died in 1907, but the company continued in business for several years, specializing in the manufacture of welded steel works.

Holdane and Company remained in business for 10 years after the end of the Civil War. R. G. Dun reported in November 1866, that the firm was "doing a good and cautious business." In 1873 Dun mentioned that Holdane had a good reputation in iron manufacturing, and "has made money." Two years later Dun noted that the company was "an old established concern doing a legitimate steady business." Nevertheless, on July 10, 1875, the company was dissolved by mutual consent. No reason was given for the decision, although a Dun report does mention that James Holdane's wife had inherited considerable money.[181]

The *Monitor* companies located outside New York City also survived in the postwar years. Clute Brothers specialized in Ericsson's caloric engine and in repairing machinery for vessels plying the Erie Canal. In 1876 the company received a contract to manufacture Lay torpedoes. That same year Cadwallader C. Clute, who had managed the works since 1842, died. In 1879, Clute Brothers closed down.[182]

The Niagara Steam Forge in Buffalo advertised in 1866 that they manufactured "all kinds of light and heavy forgings and hammered shapes for rail roads, steamboats and propellers, such as car axles, crank axles, truck and driving axles, wrought iron driving wheels, locomotive frames, steamboat and propeller shafts and cranks, connecting rods, piston rods, crank pins, mill shafts, anchors, hammered bar iron and shafting of any length and size."[183]

Patchin joined Charles Delaney as a partner in the works. Four years later, he sold out to Delaney. Shortly afterward the company was reorganized as the Delaney Forge & Iron Company. Charles Delaney died in 1883, but his son continued the business until his death in 1902. The firm was then reorganized as a corporation and continued in business until the mid 1920s.[184]

Rensselaer Ironworks and the Albany Ironworks in Troy emerged in the postwar years as leading firms in the nations new steel industry. In 1863 Alexander L. Holley, an engineer and one of the editors of the *American Railway Review,* went to England, evidently with instructions from Winslow, Corning, and Griswold, to obtain American rights to the Bessemer steel process.[185] A recent biography of Holley suggests that he consulted Ericsson after his return from England and that the Swedish engineer recommended him to the Troy entrepreneurs. However, this does not seem logical because Holley visited a Bessemer plant in 1862, returned to the United States, then went back to England in 1863.[186] Holley, in partnership with three Troy businessmen, erected the first Bessemer plant in North America on the grounds of the Rensselaer Ironworks. The Bessemer Steel Company, as the new firm was named, began producing steel in February 1865. Despite complications concerning patent rights, the depression of the 1870s that resulted in the works temporarily closing down, and a series of labor strikes, the Bessemer facility and the two parent ironworks continued to expand throughout the two decades following the end of the war.[187]

During those years the Troy iron and steel works produced steel rails, structural steel, axles, nails, plate, angle and bridge iron, and "merchant iron." In 1866 Troy even cast an experimental steel cannon. There is no evidence that they sought government contracts, although its interest in ordnance suggests that they probably did so. The firm's business relationship with Ericsson endured only briefly. Griswold acted as his agent in Washington, and he and Winslow persevered in backing the Swedish inventor financially.[188] That changed in 1867. Winslow retired, selling out his interest in the works to Griswold. In 1866 Griswold, who was still in the House of Representatives, changed committee assignments, going from the Naval Affairs Committee to the Ways and Means Committee. In 1868 he was an unsuccessful candidate on the Republican ticket for the governorship of New York.[189]

In 1875 Corning and Griswold consolidated the iron and steel works into the Albany and Rensselaer Iron & Steel Company. In 1885 the firm was incorporated as the Troy Steel and Iron Company. In 1903 the United States Steel Corporation acquired the Troy works. Griswold died in 1872, Corning shortly after. The iron and steel works under new management prospered until the early 1890s. The depression of 1893 triggered a decline, and long before U.S. Steel obtained the works, Troy Steel was idle and in receivership.[190]

New York's proud citizens erected this monument to John Ericsson in Battery Park in 1894. Monitor was primarily a New York product. Most of the vessel was fabricated and constructed in the city, principal center for iron shipbuilding and marine steam engineering during the 1850s and 1860s. (National Park Service photograph by James P. Delgado)

Like the Troy companies, Abbott & Son of Baltimore continued expanding in the post-Civil War years. After the war ended, the ironworks incorporated as the Abbott Iron Company, with Horace Abbott, the firm's longtime owner, as president. By 1882 the establishment covered approximately 11 acres and consisted of three plate mills and one rail mill. In those years the company concentrated in the manufacture of railroad rails, and boiler and plate iron. Employees varied from 500 to a thousand. Horace Abbott died in 1887, but the company continued into the present century. Abbott & Son, which fabricated more armor plate for warships than any other firm during the Civil War, apparently made no effort to seek government work when the new steel warships were laid down in the mid-1880s. Instead, the plant specialized in railroad and domestic iron and steel until it closed down.[191]

The Civil War was fought at a time when the United States was accelerating toward industrial importance. The nation was already one of the world's industrial leaders in 1860, with manufacturing employing almost one-seventh of the labor force. Before the war, American contributions in industrial and transportation technology had been gaining recognition. The American exhibits at the Crystal Palace Exposition in London in the mid-1850s impressed Europeans. Other inventions, particularly in domestic industries, illustrated American ingenuity. Cyrus McCormick's reaper and the sewing machines of Elias Howe and Isaac Singer were sold abroad. By the war's outbreak, Singer's European outlets were selling more sewing machines than some 3,000 salesmen could sell in the United States.[192]

The Civil War clearly stimulated developments in technology. "It was the first struggle in which science and machinery played a dominant part, and it was the first time that technological innovations and improvements were applied on a large scale in a major war." Bernard and Fawn Brodie agreed: "The American Civil War was a colossal proving ground for improving weapons of all kinds. For the first time the achievements of the industrial and scientific revolution were used on a large scale in war." Ericsson himself wrote that "the time has come, Mr. President [Lincoln], when our cause will have to be sustained not by numbers, but by superior weapons. By a proper application of mechanical devices alone will you be able with absolute certainty to destroy the enemies of the Union."[193] The most famous of these "mechanical devices" was the one designed by Ericsson—*Monitor*.

Monitor has been characterized as symbolic of industrial and transportation revolutions that transformed the United States in the 19th century. The companies that built the warship were not only representative of those revolutions, but were significantly involved in the technological developments that made them possible. The history of these companies graphically illustrates the emergence of the United States as an industrial nation.

Notes

[1]See William T. Hogan, *An Economic History of the Iron and Steel Industry in the United States* (Lexington, Mass., 1971); Peter Temin, *Iron and Steel in Nineteenth-Century America: An Economic Inquiry* (Cambridge, Mass., 1961); and Elting E. Morison, *From Know-How to Nowhere, The Development of American Technology* (New York, 1974), hereafter cited as Morison, *From Know-How to Nowhere.*

[2]Louis C. Hunter, "Heavy Industry Before 1860," in *The Growth of the American Economy* (New York, 1944), ed. Harold F. Williamson, 211; see also Douglas A. Fisher, *The Epic of Steel* (New York, 1963).

[3]Fisher, *The Epic of Steel,* 97; George Rogers Taylor, *The Transportation Revolution, 1815-1860* (New York, 1951), 208.

[4]Fisher, *The Epic of Steel,* 98. Redlich says 1819. Fritz Redlich, *History of American Business Leaders: Theory, Iron & Steel, Iron Ore Mining* (Ann Arbor, Mich., 1940) I, 83.

[5]Fisher, *The Epic of Steel,* 99.

[6]Hogan, *An Economic History,* I, 5, 12; Fisher, *The Epic of Steel,* 99.

[7]Hogan, *An Economic History,* I, 12-13; *History of The State of New York* (6 vols., Port Washington, New York, 1962), V, 206-208.

[8]Holdane & Company to John Griswold, October 19, 1861, John Griswold Papers, Division of Armed Forces History, Smithsonian Institution, Washington, D.C., hereafter cited as Griswold papers; drawing of angle iron provided Holdane & Company, October 14, 1861, copy in *Monitor* Archives, Program in Maritime History and Underwater Research, East Carolina University, Greenvile, North Carolina; *The Scientific American,* new series, V(October 23, 1861), 331.

[9]New York, Vol. 323, p. 890a, R. G. Dun & Co. Collection, Baker Library, Harvard University Graduate School of Business Administration, Boston, Mass., hereafter cited as Dun Col.

[10]New York, Vol. 393, p. 890a, Dun Col.

[11]New York, Vol. 393a, p. 890a, Dun Col.

[12]A. Z. Holley and Lenox Smith, "American Iron and Steel Works," *Engineering,* XV(December, 1880), 590; Edward Hungerford, *Pathway of Empire* (New York, 1935, 286.

[13]Irene D. Neu, *Erastus Corning, Merchant and Financier, 1794-1872* (Ithaca, New York, 1960), 54, hereafter cited as Neu, *Corning.*

[14]Neu, *Corning,* 39; "Erastus Corning," *Dictionary of American Biography,* IV, 446, hereafter cited as *D.A.B.*; Arthur J. Weise, *Troy's One Hundred Years, 1789-1889* (Troy, New York, 1891), 264, hereafter cited as Weise, *Troy.*

[15]Weise, *Troy,* 264; Neu, *Corning,* 39-40; Redlich, *History of American Business Leaders,* I, 96.

[16]Samuel Rezneck, "John Flack Winslow (1810-1892), Troy Iron and Steel Master," in *Profiles Out of the Past of Troy, New York, Since 1789,* (Troy, New York, 1946), 97.

[17]Neu, *Corning,* 42.

[18]Redlich, *History of American Business Leaders,* I, 96; J. Leander Bishop, *A History of American Manufactures from 1608 to 1860* (third ed., 3 vols., New York, 1966), III, 251.

[19]Neu, *Corning,* 42-43. This work is based on an extensive examination of the Corning manuscript Collection. It is the best account of the early years of the iron works.

[20]Bishop, *American Manufactures,* III, 250. The "chair-machinery" produced rails.

[21]Bishop, *American Manufactures,* III, 632-633; Neu, *Corning,* 42-44; the *Troy Business Directory for the Year 1861...* (Troy, 1860), 88, 295; Daniel J. Walkowitz, *Worker City,Company Town: Iron and Cotton-Worker Protests in Troy and Cahoes, New York, 1855-84* (Urbana, Illinois, 1978,) 23.

[22]J. P. Lesley, *The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States* (New York, 1866), 225.

[23]Neu, *Corning,* 47-48. Weise claims that Winslow owned the mill first and sold it to Griswold. Weise, *Troy,* 265. The Troy Business Directory of 1862 includes an advertisement for the Rensselaer Iron Works that lists Griswold as "agent." *The Troy Directory for the year 1862....* (Troy, n.d.), 1. Advertising at back of the directory with new pagination. Copies of Troy directories in Library of Congress.

[24]"John Griswold," *D.A.B.,* VIII, 8-9; Neu, *Corning,* 47-49; Rezneck, "John Augustus Griswold (1818-1872) Business and Civil Leader of Troy," in *Profiles out of the Past of Troy, New York Since 1789,* 101-103.

[25]Rezneck, "Griswold," 101. See also Lesley, *The Iron Manufacturers Guide,* 3.

[26]"John Flack Winslow," *D.A.B.,* X, 399. The Albany Iron Works was also beginning to use steel in its manufactured railroad products. *The Scientific American,* new series, IV (January 5, 1861), 3.

[27]Gordon P. Watts, Jr., "Monitor of a New Age: The Construction of the U.S.S. *Monitor.*" M.A Thesis, East Carolina University, 1975, 51; Stimers to Ericsson, May 6, 1862, John Ericsson Papers, New York Historical Society, New York City.

[28]Henry P. Smith, *History of Buffalo and Erie County* (2 vols., Syracuse, 1884), II, 240; Henry W. Hill, *Municipality of Buffalo, New York: A History, 1720-1923* (2 vols., New York, 1923), II, 862; *The Manufacturing Interests of the City of Buffalo* (second edition, Buffalo, 1866), 50.

[29]Mark Goldman, *High Hopes: The Rise and Decline of Buffalo, New York* (Albany, 1983), 64, hereafter cited as Goldman, *High Hopes: The Manufacturing Interests of the City of Buffalo Including Sketches of the History of Buffalo* (Buffalo, 1866), 72. A copy of this directory is in the Library of Congress.

[30]*The Buffalo City Directory for the Year 1862* (Buffalo, 1861), listed him as a ship's carpenter. See page 170.

[31]*Buffalo Commercial Advertiser,* September 24, 1883.

[32]Copy of advertisement in *The Buffalo City Directory for the Year 1862,* 83; *The Manufacturing Interests of the City of Buffalo,* 50-51.

[33]Sherry H. Olson, *Baltimore: The Building of an American City* (Baltimore, 1980), 77.

[34]Peter Cooper," *D.A.B.,* IV, 409-410. See also Allan Nevins, *Abram S. Hewitt With Some Account of Peter Cooper* (New York, 1935) and Edward C. Mack, *Peter Cooper: Citizen of New York* (New York, 1949).

[35]Mack, *Peter Cooper,* 117. Most authorities say that Abbott purchased the iron works in 1836, but Cooper's biographer (Mack) using his manuscripts has concluded that it was 1847.

[36]"Horace Abbott," *D.A.B.,* I, 21; "Horace Abbott," in pamphlet file, Maryland Historical Society, Baltimore; J. Thomas Scharf, *History of Baltimore City and County* (Philadelphia 1881), 427; ____ , *Chronicles of Baltimore* (Baltimore 1874), 490; Gary L. Browne, *Baltimoe in the Nation, 1789-1861* (Chapel Hill, North Carolina, 1980), 182, 287; Victor S. Clark, *History of Manufactures in the United States* (2 vols., New York, 1929), II, 506, hereafter cited as Clark, *Manufactures;* Baltimore *Sunday Sun Magazine,* July 26, 1953. The 1858 city directory, *The Monumental City or Baltimore Guide Book,* does not mention the iron works, but an 1864 directory does. Copies of these directories are found in the Library of Congress.

[37]Lesley, *The IRON Manufactures Guide,* 243.

[38]Bishop, *American Manufactures,* III, 116-117.

[39]Temin, *Iron and Steel in Nineteenth Century America,* 40-41; Nathan Rosenberg, *Technology and American Economic Growth* (New York, 1972), 64; Taylor, *Transportation Revolution,* 223.

[40]Rosenberg, *Technology and American Economic Growth,* 67.

[41]Rosenberg, *Technology and American Economic Growth*, 69; Taylor, *Transportation Revolution*, 58.

[42]Cedric Ridgely-Nevitt, *American Steamships on the Atlantic* (Newark, Delaware, 1981), 348, hereafter cited as Nevitt, *American Steamships.*

[43]Robert G. Albion, *The Rise of New York Port, 1815-1860* (New York, 1939), 148. See also Fred E. Dayton, *Steamboat Days* (New York, 1939), 376; and Leonard A. Swann, Jr., *John Roach, Maritime Entrepreneur* (Annapolis, Maryland, 1965), 181. Philadelphia, with firms such as Merrick & Towne, Merrick & Sons, and Reaney & Neafie, won a close second in engine works.

[44]Bishop, *American Manufactures*, III, 122.

[45]*The Scientific American*, IX (December 17, 1853), 110; Carroll W. Pursell, Jr., *Early Stationary Steam Engines in America* (Washington, D.C., 1969). See also Pursell's dissertation, "Stationary Steam Engines in America before the Civil War,", PhD dissertation, University of California, Berkeley, 1964, 183, hereafter cited as Pursell, "Stationary Steam Engines."

[46]*The Scientific American*, new series, IV (March 23, 1861), 186.

[47]Pursell says 1927. See *Stationary Steam Engines*, 24.; Codman Hislop, "The S.S. *Novelty*," *New York Historical Society Quarterly*, 49 (October, 1965), 330 gives the date as 1831; and Dayton, *Steamboat Days* suggests 1833 (p. 382). See also Codman Hislop, *Elipholet Nott* (Middleton, Conn., 1971), 352, *passim.*

[48]Pursell, "Stationary Steam Engines."

[49]Bishop, *American Manufactures*, III, 125-126. *Novelty* was enrolled on January 9, 1833.

[50]Hislop, "The S.S. *Novelty*," 329.

[51]Bishop, *American Manufactures*, III, 126

[52]Quoted in John H. Morrison, *History of American Steam Navigation* (New York, 1903), 52-53. See also, Dayton, *Steamboat Days*, 43, 382; and Hislop, "The S.S. *Novelty*," 329.

[53]New York, Vol. 368, p. 401, Dun Col.

[54]John A. Kouwenhoven, *Partners in Banking...Brown Brothers, Harriman & Co., 1818-1968* (Garden City, 1968), 241. See also John Crosby Brown, *A Hundred Years of Merchant Banking* (New York, 1909), 241.

[55]Kouwenhoven, *Partners in Banking*, 153; New York, Vol. 368, P. 401, Dun Col.; Peter Cooper also purchased stock in the company. Mack, *Peter Cooper*, 199.

[56]There is a large number of brief biographical sketches of Allen. For some of the better ones see Alfred Mathews, "Horation Allen," *Cassier's Magazine*, X (May-June, 1986), 471-474; Edward H. Mott, *The Story of Erie* (New York, 1980), 462; "Horatio Allen," *D.A.B.*, I, 193-194; "A Memorial of Horatio Allen," *Transactions of the American Society of Mechanical Engineers*, II (November, 1889-May, 1980), 1156-1181.

[57]Taylor, *Transportation Revolution*, 32-52; "Allen," *D.A.B.*, I, 193. See also Robert H. Thurston, *A History of the Growth of the Steam-Engine* (New York, 1878), 208. *Stourbridge Lion* made only two runs and because of her weight crushed the hemlock rails. The locomotive was then put in storage and never used again. Morison, *From Know-How to Nowhere*, 52. For Allen's involvement with the Delaware and Hudson Company see *A Century of Progress: History of the Delaware and Hudson Company, 1823-1923* (Albany, New York, 1926), 46-61.

[58]Nevins, *Hewitt*, 70.

[59]For Allen's work with the South Carolina Railroad see Samuel M. Derrick, *Centennial History of South Carolina Railroad* (Columbia, S.C., 1930), 31-78; Morison, *From Know-How to Nowhere*, 54-56.

[60]Nelson M. Blake, *Water for the Cities, A History of The Urban Water Supply Problem in the United States* (Syracuse, 1956), 145-153; Morison, *From Know-How to Nowhere*, 62-69.

[61]Nevins, *Hewit*, 199; Mott, *The Story of Erie*, 67-73; Edward Hungerford, *Men of Erie* (New York 1946), 65-67.

[62]Alex Perez-Venero, *Before the Five Frontiers, Panama From 1821-1903* (New York, 1978), 63.

[63]"A Memorial for Horatio Allen, "*Transactions of the American Society of Mechanical Engineers,* 1740; T. Main, *The Progress of Marine Engineering* (New York, 1893), 28, hereafter cited as Main, *Marine Engineering.*

[64]Charles T. Porter, *Engineering Reminiscences Contributed to "Power" and "American Machinist"* (New York, 1908), 254, hereafter cited as Porter, *Engineering Reminiscences.*

[65]Nevitt, *American Steamships,* 153. True also of *Adriatic.*

[66]"Memorial for Horatio Allen," *Transactions of the American Society of Mechanical Engineers,* 1174.

[67] "Memorial for Horatio Allen," *Transactions of the American Society of Mechanical Engineers,* 1174-1175.

[68]*Annual Report of the U. S. Commissioner of Navigation* (Washington, D.C., 1894), 268. For Novelty's prominence see Louis C. Hunter, *A History of Industrial Power in the United States 1780-1930. Volume Two: Steam Power* (Charlottesville, Virginia, 1985), 242-243.

[69]Nevitt, *American Steamships,* 98.

[70]Carl C. Cutler, *Queens of the Western Ocean* (Annapolis, Maryland, 1961), 277. Horatio Allen was one of the company's directors. Newitt, *American Steamships,* 128-130. See Also David B. Tyler, *Steam Conquers the Atlantic* (New York, 1939), 154-156.

[71]Main, *Marine Engineering,* 30-31; John G. B. Hutchins, *The American Maritime Industries and Public Policy, 1789-1914* (Cambridge, 1941), 354, 355; Frank C. Bowen, *A Century of Atlantic Travel, 1830-1930* (Boston, 1930), 56-67.

[72] Alexander Crosby Brown, *Women and Children Last: The Loss of the Steamship Arctic* (New York, 1961). Thurston in *A History of the Growth of the Steam Engine* said that the *Arctic's* machinery "was for that time remarkably powerful and efficient." p. 290. See also *The Scientific American,* IX (October 1, 1853), 78.

[73]For a detailed account of the Atlantic liners including those with Novelty-supplied machinery see Nevitt, *American Steamships.*

[74]John Haskell Kemble, *The Panama Route, 1848-1869* (Berkeley, 1943) 118-119. For a list and brief history of these vessels see Kemble, 213-251.

[75]Dayton, *Steamboat Days,* 383; Porter, *Engineering Reminiscences,* 55; Nevitt, *American Steamships,* 167-169.

[76]Tyler, *Steam Conquers the Atlantic,* 237; Nevit, *American Steamships,* 167-169; New York Vol. 368, p. 440, Dun Col.

[77]Nevitt, *American Steamships,* 262-263. See also Franklin N. Chance. et al., *Tangled Machinery and Charred Relics: The Historical and Archaeological Investigation of the C.S.S. Nashville* (Orangeburg, S.C., 1985).

[78]*The Scientific American,* IX (April 29, 1854), 262.

[79]*The Scientific American,* new series, III (October 13, 1860), 240.

[80]*The Scientific American,* new series, III (December 1, 1860), 256; New York, Vol. 368, p. 440, Dun Col.

[81]*The Argument of Mr. Edward N. Dickerson...in the Case of Sickels vs. Borden, Defended by 'The Novelty Iron Works' and Mr. Horatio Allen* (New York, 1856), 14.

[82]Porter, *Engineering Reminiscences,* 65. See also *The Scientific American,* new series, I (September 3, 1859), 149; II (April 7, 1860), 78; III (October 6, 1860), 234. For fire engines the April 7, 1860 issue of *The Scientific American* shows a Novelty built engine. For sugar machinery see Albion, *The Rise of New York Port,* 178.

[83]Clark Reynolds, "The Great Experiment; Hunter's Horizontal Wheel," *American Neptune,* XXIV (January, 1964), 6-7.

[84]*The Scientific American,* new series, II (March 11, 1860), 79.

[85]Dayton, *Steamboat Days,* 383.

[86]"The Novelty Works," in *Harper's New Monthly Magazine,* II (May, 1851), 721-734. See also Albion, *The Rise of New York Port,* 150-151; Tyler, *Steam Conquers the Atlantic,* 179; Bishop, *American Manufactuers,* III, 127; *The Scientific American,* IX (December 17, 1863), 110. A British Parliamentary committee investigating manufacturing in the U.S visited the Novelty works and reported they "did not see any thing new to them, or any machinery not used in similar works in Great Britain." *The American System of Manufactures,* ed., Nathan Rosenberg (Edinburgh, 1969), 105. Benjamin F. Isherwood, later Engineer in Chief of the Navy, learned about marine engines while he was employed at the Novelty works in the 1840s. Edward William Sloan III, *Bemjamin Franklin Isherwood, Naval Engineer,* (Annapolis, 1965), 9. John Rogers, well known 19th century sculptor, was employed at Novelty, 1852-1853. See David H. Wallace, *John Rogers; the People's Sculptor,* (Middleton, Connecticut, 1967).

[87]John H. Morrison, *History of New York Ship Yards,* (New York, 1909) 150.

[88]New York, Vol. 368 p. 440, 441, Dun Col.;

[89]*The Scientific American,* new series, III (December 22, 1860), 408.

[90]*The Scientific American,* new series, IV (March 23, 1861), 186.

[91]Holbrook Fitz John Porter, *The Delamater Iron Works—The Cradle of the Modern Navy* (New York, 1918); Dayton, *Steamboat Days,* 384-385; Bishop, *American Manufactures,* III, 129-130.

[92]Dayton, *Steamboat Days,* 384; Porter, *The Delamater Iron Works,* 5. For Cornelius Delamater see *D.A.B.,* V, 211-212; *American Machinist,* XII (1899), 7; *Transactions, American Society of Mechanical Engineers,* X (October, 1888), 386-388.

[93]William C. Church, *The Life of John Ericsson,* (2 vols., New York, 1911), I, 244.

[94]Porter, *The Delamater Iron Works,* 5; Church, *Ericsson,* I, 244. An obituary for Delamater said that he "did more for Captain Ericsson than any one else engaged in the line of engineering." *American Machinist,* XII (1889), 7. See also *D.A.B.,* V, 211.

[95]Watts, "Monitor of A New Iron Age," 60-61.

[96]A Dun report dated June 23, 1855 said: "Have not learned upon what terms [Delamater] purchased out his partner, but he is believed to have strength to go on alone....Those who know him have great confidence in his integrity and reliability." New York, Vol. 316a, 180, Dun Col.

[97]James P. Baughman, *The Mallorys of Mystic* (Middletown, Connecticut, 1972), 117.

[98]Bishop, *American Manufactures,* III, 130.

[99]Bishop, *American Manufactures,* III, 132.

[100]New York, Vol. 316a, 185, Dun Col.

[101]Porter, *The Delamater Iron Works,* 6-7; Ericsson to Sargent, April 23, 1845, Ericsson Papers, American Swedish History Museum; *The Scientific American,* new series, V (July 6, 1861).

[102]Lee M. Pearson, "The *Princeton* and the 'Peacemaker': A Study in Nineteenth-Century Naval Research and the Development Procedures," *Technology and Culture,* VII (Spring, 1966), 164. Frank M. Bennett in *The Steam Navy of the United States* (Pittsburgh, 1896), 62, states that the machinery was built by Merrick & Towne. Church in his biography of Ericsson gives Hogg and Delamater credit for building it (Vol. I, 226). So does Robert MacFarlane, Editor of *The Scientific American.* See his *History of Propellers and Steam Navigation* (New York, 1851), 116-117. Ericsson had difficulty collecting compensation from the Navy Department and did not seek government work again until 1854 when he proposed to design machinery for five auxiliary steamers; the work to be done at Hogg & Delamater. He did not get the contract. Ericsson to Secretary of the Navy, August 30, 1854, Ericsson Papers, American Swedish History Museum. For Ericsson's problems with the Navy Department see Church, *Ericsson,* I, 140-154.

[103]Nevitt, *American Steamships,* 83-83; Church, *Ericsson,* I, 109-110.

[104]Robert B. Forbes, *Personal Reminiscences* (2d. edition, Boston, 1882), 208-210; Nevitt, *American Steamships,* 86.

[105]A large number of Ericsson-designed propellers were built by Great Lakes firms. For many of the vessels that Hogg & Delamater provided machinery, see Dayton, *Steamboat Days;* Forbes, *Reminiscences;* Nevitt, *American Steamships; The Scientific American,* new series IV (January 12, 1861), 28; Main, *The Progress of Marine Engineering,* 33.

[106]Baughman, *The Mallorys of Mystic,* 102-103. Baughman wrote, "For machinery, the Mallory yard depended primarily on the Delamater Iron Works [and two local works]...Delamater filled the bulk of Mallory's order for engines, boilers, shafts, pumps, and winches." p. 117. See also *The Scientific American,* new series, II (February 25, 1860), 131; (March 23, 1860), 182.

[107]New York, Vol. 316a, 180, Dun Collection.

[108]John B. Kitching, *Ericsson's Caloric Engine* (New York, 1859); Eugene Ferguson, "John Ericsson and the Age of Caloric," *Bulletin No. 298: Contributions from the Museum of History and Technology* (Washington, D.C., 1963); *Ericsson's Contributions to the Centennial Exhibition* (New York, 1876); *Articles Descriptive of the Caloric Ship Ericsson and of her Trial Excursion of January 19, 1853, Taken from the Daily Journals of the City of New York* (Washington, D.C., 1853).

[109]Dayton, *Steamboat Days,* 56.

[110]*The Scientific American,* new series, I(October 8, 1859), 255; *Journal of the Franklin Institute,* 1860, 185.

[111]Myron S. Westover, ed., *Schenectady City and County Directory for 1862* (Schenectady, 1862), 36. A copy of this directory is in the Library of Congress. Joel H. Monroe, *Schenectady Ancient and Modern* (Geneva, New York, 1914), 247-248.

[112]Kitching, *Ericsson's Caloric Engine,* 9

[113]For biographical sketches of Rowland see the *D.A.B.; Harper's Weekly,* VI (September 6, 1862), 1; *The Nautical Gazette,* January 13, 1875. Although trained as an engineer, Rowland called himself a shipbuilder. See the *Brooklyn City Directory for the year ending May 1st, 1963,* 375. A copy of this directory is located in the Library of Congress.

[114]In April 1861 the Harriet Lane was the vessel ordered to carry supplies to Fort Sumter in Charleston, South Carolina. This led to the firing on the fort by Southerners and the beginning of the Civil War. For a detailed description of the vessel, including drawings of the hull, see *The Scientific American,* new series, I (October 8, 1859), 242. For the Sneeden yard see "The Shipbuilding Industry in Brooklyn," *Brooklyn Life,* LIX (April 26, 1919) 141; Harold C. Syrett, *The City of Brooklyn, 1865-1898* (New York), 1968, 15-16.

[115]Syrett, *The City of Brooklyn,* See also Dayton, *Steamboat Days,* 165, and *Harper's Weekly,* VI (September 6, 1862.

[116]Bishop, *American Manufactures,* III, 132-133.

[117]Dayton, *Steamboat Days,* 166.

[118]Sloan, *Isherwood,* 30.

[119]Sloan, *Isherwood,* 30-31; Porter, *Engineering Reminiscences,* 60. Bennett in *The Stream Navy of the United States* contradicts himself. On page 4 he writes that Novelty built four, but in his list of vessels in Appendix "B" he list six with machinery provided by Novelty. For a brief history and statistics of these vessels see the appropriate volumes in the *Dictionary of American Fighting Ships* (Washington, D.C., 1959). See also *The Scientific American,* new series, V (July 20, 1961), 54; (October 11, 1861), 192; (October 19, 1861), 250. Drawings of one of the gunboats with machinery under construction can be found in *Harper's Weekly,* August 31, 1861.

[120]*The Scientific American,* new series, V (August 17, 1861), 106.

[121]New York, Vol. 368, 441. Dun Col.

[122]Quoted in Church, *Ericsson,* I, 242. For work during the spring and summer 1861 see *Journal of the Franklin Institute* September, 1861, 202.

[123]Porter, *The Delamater Iron Works,* 8.

[124]Charles L. Dufour, *The Night The War Was Lost* (Garden City, 1960), 150-153; Robert V. Bruce, *Lincoln and the tools of War* (Indianapolis, 1956) Bishop, *American Manufactures* III, 133. For the quote on Rowland see Church, *Ericsson,* I, 258.

[125]For a detailed description of the proposed vessel see James P. Baxter, III, *The Introduction of the Ironclad Warship* (Cambridge, 1933), 250-252; "Report of Board to examine plans of iron-clad vessels, under Act of August 3, 1861 in *Report of the Secretary of the Navy in Relation to Armored Vessels* Washington, D.C., 1864, 87.

[126]Baxter, *Introduction of the Ironclad Warship,* 252, See also Church, *Ericsson,* 258-259, for a different version. In a "History of the Continental Iron Works" A. R. Whitney is mentioned as one who "furnished transportation for the iron, and later became a dealer in iron, and furnished large amounts of metal to Mr. Rowland for later vessels." Copy of "History" Provided the writer by E. W. Peterkin, 29 September, 1985.

[127]Quoted in Neu, *Corning,* 53, John Niven, *Digeon Welles, Lincoln's Secretary of the Navy* (New York, 1973), 367.

[128]*The Scientific American,* new series, IV (June 8, 1861), 356; V (September 7, 1861), 149; (November 2, 1861), 277-278. The November issue included drawings of the gun and targets.

[129]*The Scientific American,* new series, V (November 2, 1861), 276-277; and (April 12, 1862), include detailed descriptions and drawings of Winslow's plating system for the *Galena.* The *Galena* was badly damaged, at least eighteen shots penetrating her armor, when she engaged Confederate forts near Richmond in May, 1862. See also Francis B. Wheeler, *John F. Winslow, LL.D. and the Monitor* (Poughkeepsie, New York, 1893), 21.

[130]New York, Vol. 323, 890a-b Dun Col.

[131]Goldman, *High Hopes,* 124-125.

[132]See Baxter, *The Introduction of the Ironclad Warship;* Edward M. Miller, *The U.S.S. Monitor, The Ship That Launched the Modern Navy,* (Annapolis, 1979).

[133]Winslow, and Griswold, and probably Corning, secured the funds locally for the project. Jeanne McHugh, *Alexander Holley and the Makers of Steel* (Baltimore, 1980), 69-70; Neu, *Corning,* 53-55. Copies of the contract are located in the John Ericsson Papers, Library of Congress, and the Griswold Papers.

[134]Griswold to Ericsson, October 14, 1861, Ericsson Papers, American Swedish History Museum.

[135]Ericsson to Winslow, October 8, 1861; C. W. Whitney to Griswold, October 22, 1861; November 8, 1861; Rowland to Winslow, October 19, November 4, 1861, Griswold Papers; Winslow to Ericsson, September 20, October 9, 20, 1861, Ericsson Papers, American Swedish History Museum; Ericsson to Smith, October 8, 1861, Records of the office of the Chief of the Bureau, Entry 5, section 7, Miscellaneous Correspondence, 1842-1885, Letters Received, RG71, Records of the Bureau of Yards and Docks, National Archives, hereinafter cited as Entry 5, RG 71; Baxter, *Introduction of the Ironclad Warship,* 266.

[136]Ericsson to Smith, October 19, 1861, Entry 5, RG 71; Wheeler, *Winslow,* 29; Rezneck, "Winslow," 89. Winslow contracted with Delaney for the port stoppers.

[137]November 12, 1861, Holdane to Griswold, October 19, 1861, Griswold Papers.

[138]Ericsson to Clute, November 6, 1861, Griswold Papers; *The Scientific American,* new series, V (November 11, 1861), 331.

[139]A copy of the contract dated October 25, 1861 is in the Griswold Papers.

[140]John Ericsson, "The Building of the *Monitor,*" *Battles and Leaders of the Civil War,* Robert U. Johnson, and Clarence C. Buel, eds., (4 vols., New York, 1884-1888), I, 731.

[141]Watts, "*Monitor* of a New Iron Age.," 59.

[142]Ernest W. Peterkin, "Building a Behemoth," *Civil War Times Illustrated,* XX (July, 1981), 17.

[143]Ericsson tried a kind of mass-production method with these vessels. "They would be alike in every particular. For instance the main frames of the engines of 5 of these vessels have been cast from one pattern at the Delamater Iron Works. The turret engines...have been cast from one pattern." Ericsson to Bennett, June 27, 1862, Ericsson Papers, American Swedish History Museum.

[144]Neu, *Corning*, 55.

[145]November 5, 1862 in Court of Claims of the United States, *Report of Navy Department Documents Relating to the Harbor and River Monitors Manhattan, Mahopac, and Tecumseh* (Washington, D.C., 1912), 1029, hereinafter cited as *Documents Relating to the Harbor and River Monitors.* See additional correspondence *Documents Relating to the Harbor and River Monitors,* 1029-1031. For Abbott see Olson, *Baltimore,* 145; Bill of H. Abbott for dock plate, March 16, 1863, in *Documents Relating to the Harbor and River Monitors,* 1519; Scharf, *Chronicles of Baltimore,* 490-491; Bishop, *American Manufactures,* III, 116; *The Scientific American,* new series, VII (November 8, 1862), 298. For Holdane see New York, Vol. 323, G890a, Dun Col. Clute may have provided parts.

[146]Ericsson to Clute Brothers, January 15, 1865, Ericsson Papers, American Swedish History Museum.

[147]For contracts see Entry 231, *Records of the United States General Accounting Office, RG231,* National Archives. See *Dictionary of American Naval Fighting Ships,* III, 762-764 for data. Church's *Ericsson* discusses the two vessels but ignores their failings. Robert Johnson in *Rear Admiral John Rodgers, 1812-1882* (Annapolis, 1967), 261-279 is far more objective, particularly of the *Dictator* that Rodgers commanded. See also *The Scientific American,* new series, VIII (January 17, 1863), 41; and IX (April 2, 1864), 217. Porter in *The Delamater Iron Works* is in error when he gives Delamater credit for building *Puritan's* machinery (12).

[148]Gideon Welles, *Diary of Gideon Welles,* ed. Howard K. Beale (3 vols., New York, 1960), II 2-1-201, 207.

[149]Bishop, *American Manufactures,* III, 133; *Harper's Weekly,* September 6, 1862. *The Scientific American,* new series, VIII (May 23, 1863), 330; *Documents Relating to the River and Harbor Monitor,* 1474, 1529.

[150]*Harper's New Monthly Magazine,* XXV (November 8, 1862), 298.

[151]*The Scientific American,* new series, VII (November 8, 1862), 298.

[152]Letter in *Documents Relating to the Harbor and River Monitors,* 1520.

[153]*The Scientific American,* new series, VII (September 27, 1862), 201; (November 8, 1862), 297; (October 11, 1862), 234; (August 2, 1820), 73. See also Henry R. Stiles, *The...History and Commercial and Industrial Record of the County of Kings and the City of Brooklyn, N.Y.,* from 1683 to 1884 (2 vols., New York, 1884), ii 498.

[154]Augustus C. Buel, *The Memoirs of Charles H. Cramp* (Philadelphia, 1906), 72-85.

[155]Dana M. Wegner, "Alban C. Stimers and the Office of the General Inspector General of Ironclads, 1862-1864," M.A. thesis, State University of New York, Oneonta, 1979, 29.

[156]Wegner, "Alban C. Stimers," 47.

[157]*Documents Relating to the Harbor and River Monitors,* 1529.

[158]Scharf, *Chronicles of Baltimore,* 490; *Sunday Sun Magazine* (Baltimore), July 26, 1953. For the mortar beds see Nevins, *Hewitt,* 202-203; Dufour, *The Night the War Was Lost,* 149-155; Bruce, *Lincoln and the Tools of War,* 156-164; Cooper, Hewitt & Co., to General Ripley, January 24, 1862; *The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies.* (130 Vols., Washington, D.C. 1880-1901), Ser III, vol. I, 899, hereinafter cited as O.R.A.. See also correspondence concerning the monitor beds in O.R.A., Ser. III, vol. I, 810, 874, 878, 884, 887. No information has been found to suggest what Abbott provided to receive the commendation.

[159]Smith, *History of Buffalo,* II, 240-241; John T. Norton, et. al., *History of Northwestern New York* (3 vols., New York, 1942), I, 185.

[160]Sloan, *Isherwood,* 56.

[161]For a detailed description of Novelty's work on the *Roanoke,* including drawings, see *Harper's New Monthly Magazine,* XXV (September, 1862), 434-442. See also *The Scientific American,* new series, VII (July 26, 1862), 57; VI (October 11, 1862), 226; VII (December 6, 1862), 362; VIII (January 31,1863), 73-74; (April 4, 1863), 217; (April 25, 1863), 265. For the vessel's history see John D. Alden, "Born Forty Years Too Soon," *American Neptune, XXII* (October, 1962), 252-263; and Baxter, *Introduction of the Ironclad Warship,* 304-305.

[162]Dana Wegner, "Ericsson's High Priest", *Civil War Times Illustrated,* XIII (February, 1975), 33-34; Wegner, "Alban C. Stimers. Stimers and Ericsson got along generally until early in 1863.

[163]Sloan, *Isherwood,* 90-91; *The Scientific American,* new series, X (April 2, 1864), 211-212; "A Memorial of Horatio Allen," 1175-1176. For Ericsson and Isherwood's relationship see Sloan, *Isherwood,* 143-158.

[164]Sloan, *Isherwood,* passim; Bennett, *Steam Navy of the United States,* 399, 555, 576-577.

[165]Bennett, *Steam Navy of the United States,* appendix; *The Scientific American,* new series, VIII (June 13, 1863), 378. For copies of Novelty's contracts with the Navy department see Entry 231, RD217.

[166]*The Scientific American,* new series, (February 24, 1864), 131-132; III (January 31, 1863), 74; VII (September 1, 1862), 201. See also *The Scientific American,* new series, XI (August 20, 1864), 106; X (June 11, 1864), 378; *Journal of the Franklin Institute,* January, 1863, 40, 44.

[167]New York, Vol. 368, 931, Dun Col.; *The Scientific American,* new series, VII (April 4, 1863), 229; X (April 6, 1864), 243.

[168]Baughman, *The Mallory's of Mystic,* 115; *The Scientific American,* new series, VII (August 2, 1862), 74; (November 22, 1862), 326; *Journal of the Franklin Institute,* 175-178; 341-342; 344-347; 378-380.

[169]Lance C. Buhl, "Mariners and Machines: Resistance to Technical Change in the American Navy, 1865-1869," *The Journal of American History,* LXI (December, 1974), 703-727; Walter R. Herrick, Jr., *The American Naval Revolution* (Baton Rouge, 1966), 13-38.

[170]James M. Morris, *Our Maritime Heritage* (1979), 198.

[171]Nevitt, *American Steamships,* 340, 348-349. See also Swann, *John Roach,* 23; and Syrett, *The City of Brooklyn,* 23.

[172]Henry Hall, *Report on the Shipbuilding Industry of the United States* (Washington, D.C., 1882), 202.

[173]Nevitt, *American Steamships,* 341; Elting M. Morison, *Men, Machines and Modern Times,* (Cambridge, 1966), 98-99. New York, Vol. 368, 931, Dun Col.; Pursell, "Stationary Steam Engines," 183; Kouwenhoven, *Partners in Banking,* 133-134.

[174]For Allen's involvement see David McCullough, *The Great Bridge* (New York, 1972), 22-23, passim. For Allen's social and civil life during his later years see "A Memorial for Horatio Allen," 1179-1181; George T. Strong, *Diary,* Allan Nevins and M. H. Thomas, eds., (4 vols., New York, 1952), III, passim; and Henry W. Bellows *Historical Sketch of the Union League Club of New York* (New York, 1879), passim. Allen continued to correspond with Ericsson. See, for example, Allen to Ericsson, January 19, 1872, and Ericsson to Allen, October 13, 1873, in Ericsson Papers, American Swedish History Museum.

[175]Porter, *The Delamater Iron Works,* 15-17; Church, *Ericsson,* II, 127-130; Carol W. Kimball, "The Spanish Gunboats," *The Log of Mystic Seaport,* XXII(Summer, 1970), 51-58; Baughman, *The Malloy's of Mystic,* 129-131; Lawrence A. Clayton, "The Incident of the Spanish Gunbats," unpublished manuscript, Mystic Seaport Library, Mystic Seaport, Connecticut. Ericsson designed the gunboats. See Ericsson to Delamater, December 30, 1869, Ericsson Papers, American Swedish History Museum.

[176]For example, see Ericsson to Fox, November 24, 1865, February 23, 1867, Ericsson Papers, American Swedish History Museum. *Ericsson,* II 166-170, 158 passim; Ericsson to Delamater, November 23, 1880, Ericsson Papers, American Swedish History Museum.

[177]Richard K. Morris, *John P. Holland, 1841-1914, Inventor of the Modern Submarine* (Annapolis, 1966), 35-43, 186-188; Simon Lake, *The Submarine in War and Peace* (Philadelphia, 1918), 96-111

[178]Porter, *The Delamater Iron Works,* 13-20; Church, *Ericsson* II, 284-275; "Cornelius Delamater," in *D.A.B.;* Ericsson Papers, American Swedish History Museum; advertisement for a hot air pumping engine by Delamater, dated February, 1880, copy in Eleutherian Mills Historical Library, Wilmington, Delaware. The copy includes illustrations.

[179]Supplement, January 13, 1875, See also Bishop, *American Manufactures,* III, 133; "Thomas Rowland," *D.A.B.* A 1908 advertisement included a drawing of the works showing vessels under construction and others alongside docks.

[180]*"Thomas Rowland," D.A.B.* See also advertisement for Morison suspension furnace including illustration dated 1908 in Eleutherian Mills Library, Wilmington, Delaware.

[181]Various comments of R. G. Dun & Co., in New York, Vol. 323, G900, G890a, G890b, Dun Col. No reason is given for dissolving the business.

[182]Monroe, *Schnectady, Ancient and Modern,* 241-284; Westover, *Schenectady Past and Present,* 49-50.

[183]*The Manufacturing Interests of the City of Buffalo* (Buffalo, 1866), 126. 120 hands were employed at that time. See also Smith, *History of Buffalo,* II 240.

[184]Henry W. Hill, *Municipality of Buffalo, New York, A History* (2 vols., New York, 1923), II, 802.

[185]Neu, *Corning,* 55-56; "John Flack Winslow," *D.A.B.;* Morison, *Men, Machines and Modern Times,* 140.

[186]See McHugh, *Holley,* 171-172.

[187]Weise, *Troy's One Hundred Years,* 265-266; James M. Swank, *History of the Manufacture of Iron in All Ages* (Philadelphia, 1892), 409-410; A.L. Holley and Lenox Smith, "American Iron and Steel Works," *Engineering,* XL (December 24, 1880), 590-616; Wolfgang P. Strassmann, *Risk and Technological Innovations: American Manufacturing Methods During the Nineteenth Century* (New York, 1959), 34-35; *Memorial of Alexander Lyman Holley, C.E., LL.D.* (New York, 1884), passim.

[188]Ericsson to Giswold, December 9, 1865, February 2, June 6, September 13, October 17, 1866, *Ericsson Papers, American Swedish History Museum;* Sloan, *Isherwood,* 47-48; Church, *Ericsson,* II. 187-188; Joel Munsell, *The Annals of Albany* (2d edition, Albany, 1869), 52, 54, 56.

[189]"John Flack Winslow," D.A.B.; Redlich *History of American Business Leaders I,* 96-107; Rezneck, *Profiles Out of the Past,* 99, 102-103; Wheeler, *Winslow,* 8-9. For Griswold's political career see Donald B. Chidsey, *The Gentleman from New York; A Life of Roscoe Conkling* (New Haven, 1935), 135-137, 167; James G. Blaine, *Twenty Years of Congress* (2 vols., Norwich, Connecticut, 1884), I 497, II, 252-255, 526-527; Welles, *Diary,* I, 531, II, 31; Robert P. Sharkey, *Money, Class, and Party: An Economic Study of Civil War and Reconstruction* (Baltimore, 1959), 73-passim; David M. Jordan, *Roscoe Conkling of New York: Voice in the Senate* (Ithaca, NewYork, 1971), 110-114; Michael Lee Benedict, *A Compromise of Principle: Congressional Republicans and Reconstrution, 1863-1869* (New York, 1974), 226 passim; Strong, *Diary,* IV, 231, 244.

[190]Weise, *Troy's One Hundred Years,* 266; Hogan, *Economic History of the Iron and Steel Industry in the United States,* vol. II, Pt. III, 487; Neu, *Corning,* 59-61.

[191]*Industries of Maryland: A Descriptive Review of the Manufacturing and Mercantile Industries of the City of Baltimore* (New York, 1889), 179; Baltimore *Sun Magazine,* July 7, 1953; Scharf, *History of Baltimore,* 427.

[192]William N. Still, Jr. "The Historical Importance of the *USS Monitor,*" unpublished MSS in possession of the author.

[193]Quoted in Still, "The Historical Importance of the *USS Monitor.*"

Bibliography

A Century of Progress, History of the Delaware and Hudson Company, 1823-1923. Albany, N.Y., 1925.

Albion, Robert G. *The Rise of New York Port, 1815-1860.* New York, 1939.

Alden, John D. "Born Forty Years Too Soon," *American Neptune,* XXII (October, 1962), 252-263.

"A Memorial for Horatio Allen," *Transactions of the American Society of Mechanical Engineers,* II (November, 1899-May, 1890), 1156-1181.

American Machinist, XII (1889), 7.

Articles Descriptive of the Caloric Ship Ericsson and of her Trial Excursion of January 19, 1853, Taken from the Daily Journals of the City of New York. Washington, D.C. 1853.

Baltimore *Sunday Sun Magazine,* July 26, 1953.

Baughman, James P. *The Mallorys of Mystic.* Middleton, Conn., 1972.

Baxter, James P., III. *The Introduction of the Ironclad Warship.* Cambridge, Mass., 1933.

Bellows, Henry W. *Historical Sketch of the Union League Club of New York.* New York, 1879.

Benedict, Michael L. *A Compromise of Principle: Congressional Republicans and Reconstruction, 1863-1869.* New York, 1974.

Bennett, Frank M. *The Steam Navy of the United States.* Pittsburgh, 1896.

Bishop, Leander. *A History of American Manufactures from 1608 to 1860.* 3rd. ed., 3 vols., New York, 1966.

Blaine, James G. *Twenty Years of Congress.* 2 vols., Norwich, Conn., 1894.

Blake, Nelson M. *Water for the Cities, A History of the Urban Water Supply Problem in the United States.* Syracuse, 1956.

Bowen, Frank C. *A Century of Atlantic Travel, 1830-1930.* Boston, 1930.

Brooklyn City Directory for the Year ending May 1st, 1863. 1863.

Brown, Alexander Crosby. *Women and Children Last: The Loss of the Steamship Arctic.* New York, 1961.

Brown, John Crosby. *A Hundred Years of Merchant Banking.* New York, 1909.

Browne, Gary L. *Baltimore in the Nation, 1789-1861.* Chapel Hill, 1980.

Bruce, Robert V. *Lincoln and the Tools of War.* Indianapolis, 1956.

Buell, Augustus C. *The Memoirs of Charles H. Cramp.* Philadelphia, 1906.

Buhl, Lance C. "Mariners and Machines: Resistance to Technical Change in the American Navy, 1865-1869" *The Journal of American History,* LXI (December 1974), 703-727.

Buffalo Commercial Advertiser, September 24, 1883.

Chance, Franklin N., et al. *Tangled Machinery and Charred Relics: The Historical and Archaeological Investigation of the C.S.S. Nashville.* Orange, S.C., 1985.

Chidsey, Donald D. *The Gentleman from New York: A Life of Roscoe Conkling.* New Haven, 1935.

Church, William C. *The Life of John Ericsson.* 2 vols., New York, 1911.

Clark, Victor S. *History of Manufactures in the United States.* 2 vols., New York, 1929.

Clayton, Lawrence A. "The Incident of the Spanish Gunboats," unpublished MSS, Mystic Seaport Library, Mystic, Conn.

Court of Claims of the United States. *Report of Navy Department Relating to the Harbor and River Monitors Manhattan, Mahopac, and Tecumseh.* Washington, D.C. 1912.

Cutler, Carl C. *Queens of the Western Ocean.* Annapolis, Md., 1961.

Dayton Fred E. *Steamboat Days.* New York, 1939.

Derrick, Samuel M. *Centennial History of South Carolina Railroad.* Columbia, S.C., 1930.

Dictionary of American Biography

Dictionary of American Fighting Ships. 8 vols., Washington, D.C., 1959-1981.

Dufour, Charles L. *The Night the War Was Lost.* Garden City, N. J., 1960.

Ericsson, John. Papers, New York Historical Society , New York, N.Y.

Ericsson, John. Papers. American Swedish Historica! Museum, Philadelphia, Pennsylvania.

Ericsson, John. "The Building of the *Monitor,*" *Battles and Leaders of the Civil War.* Robert U. Johnson, and Clarence C. Buel, eds., 4 vols., New York, 1884-1888.

Ericsson's Contribution to the Centennial Exhibition. New York, 1876.

Ferguson, Eugene S. "John Ericsson and the Age of Caloric," Bulletion No. 298: *Contributions from the Museum of History and Technology.* Washington, D.C, 1963.

Fisher, Douglas A. *The Epic of Steel.* New York, 1963.

Forbes, Robert B. *Personal Reminiscences.* Boston, 1882.

Goldman, Mark. *High Hopes: The Rise and Decline of Buffalo, New York.* Albany, 1983.

Griswold, John. Papers, Divison of Armed Forces History, Smithsonian Institution, Washington, D.C.

Hall, Henry. *Report on the Shipbuilding Industry of the United States.* Washington, D.C, 1882.

Harper's Weekly, VI (September 6, 1862).

Herrick, Walter R., Jr.. *The American Naval Revolution.* Baton Rouge, La., 1966.

Nevins, Allan. *Abram S. Heritt With Some Account of Peter Cooper.* New York, 1935.

Hill, Henry W. *Municipality of Buffalo, New York: A History, 1720-1923.* 2 vols., New York, 1923.

Hislop, Codman. *Eliphalet Nott.* Middletown, Conn., 1971.

_____, "The S.S. Novelty," *New York Historical Society Quarterly,* 49 (October, 1965),

History of the State of New York. 6 vols., Port Washington, N.Y., 1962.

Hogan, William T. *An Economic History of the Iron and Steel Industry in the United States.* Lexington, Mass., 1971.

Holley, A. Z., and Lenox Smith. "American Iron and Steel Works," *Engineering,* XV (December, 1880), 590.

"Horace Abbott," pamphlet file, Maryland Historical Society, Baltimore, Md.

Hungerford, Edward. *Pathway of Empire.* New York, 1935.

_____, *Men of Erie.* New York, 1946.

Hunter, Louis C. *A History of Industrial Power in the United States 1780-1930, Volume Two: Steam Power.* Charlottesville, Va., 1985.

_____, "Heavy Industry Before 1860," in *The Growth of the American Economy.* New York, 1944.

Hutchins, John G. B. *The American Maritime Industries and Public Policy, 1789-1914.* Cambridge, Mass., 1941.

Industries of Maryland: A Descriptive Review of the Manufacturing and Mercantile Industries of the City of Baltimore. New York, 1889.

Johnson, Robert. *Rear Admiral John Rodgers, 1812-1882.* Annapolis, 1967.

Journal of the Franklin Institute

Kemble, John Haskell. *The Panama Route, 1848-1869.* Berkeley, Calif., 1943.

Kimball, Carol W. "The Spanish Gunboats," *The Log of Mystic Seaport,* XXII (Summer, 1970), 51-58.

Kitching, John B. *Ericsson's Caloric Engine.* New York, 1859.

Kouwenhoven, John A. *Partners in Banking...Brown Brothers, Harriman & Co., 1818-1968.* Garden City, N.J., 1968.

Lake, Simon. *The Submarine in War and Peace.* Philadelphia, 1918.

Lesley, J. P. *The Iron Manufacturer's Guide to the Furnaces, Forges, and Rolling Mills of the United States.* New York, 1866.

McCullough, David. *The Great Bridge.* New York, 1972.

McFarlane, Robert. *History of Propellers and Steam Navigation.* New York, 1851.

McHugh, Jean. *Alexander Holley and the Makers of Steel.* Baltimore, 1980.

Mack, Edward C. *Peter Cooper: Citizen of New York.* New York, 1949.

Main, T. *The Porgress of Marine Engineering.* New York, 1893.

Mathews, Alfred. "Horatio Allen," *Cassier's Magazine,* X (May-June, 1896), 471-474.

Memorial of Alexander Lyman Holley, C.E., LL.D.. New York, 1884.

Miller, Edward M. *The U.S.S. Monitor, The Ship That Launched the Modern Navy.* Annapolis, 1979.

Monroe, Joel H. *Schenectady Ancient and Modern.* Geneva, N. Y., 1914.

Morison, Elting E. *From Know-How To Nowhere, The Development of American Technology.* New York, 1974.

_____, *Men, Machines, and Modern Times.* Cambridge, Mass., 1966.

Morris, James M. *Our Maritime Heritage.* Washington, D.C., 1979.

Morris, Richard K. *John P. Holland, 1841-1914, Inventor of the Modern Submarine.* Annapolis, 1966.

Morrison, John H. *History of American Steam Navigation.* New York, 1903.

_____. *History of New York Ship Yards.* New York, 1909.

Mott, Edward H. *The Story of Erie.* New York, 1908.

Munsell, Joel. *The Annals of Albany.* 2d. ed., Albany, N.Y., 1869.

Neu, Irene D. *Erastus Corning, Merchant and Financier, 1794-1872.* Ithaca, N. Y., 1960.

Niven, John. *Gideon Welles, Lincoln's Secretary of the Navy.* New York, 1973.

Norton, John T., et al. *History of Northwestern New York.* 3 vols., New York, 1942.

Olson, Sherry H. *Baltimore: The Building of an American City.* Baltimore, 1980.

Pearson, Lee M. "The *Princeton* and the 'Peacemaker': A Study in Nineteenth-Centuury Naval Research and the Development Procedures," *Technology and Culture,* VII (Spring, 1966), 163-183.

Perez-Venero, Alex. *Before the Five Frontiers, Panama From 1821-1903.* New York, 1978.

Peterkin, Ernest W., "Building a Behemoth," *Civil War Times Illustrated,* XX (July, 1981), 12-19.

Porter, Charles T. *Engineering Reminiscences Contributed to "Power" and "American Machinist".* New York, 1908.

Porter, Holbrook Fitz John. *The Delamater Iron Works—The Cradle of the Modern Navy.* New York, 1918.

Pursell, Carroll W., Jr., *Early Stationary Steam Engines in America.* Washington, D.C., 1969.

_____, "Stationary Steam Engines in America before the Civil War," PhD dissertation, University of California, Berkeley, 1964.

Redlich, Fritz. *History of American Business Leaders: Theory, Iron & Steel, Iron Ore Mining.* Ann Arbor, Michigan, 1940.

Rezneck, Samuel, "John Flack Winslow (1810-1892), Troy Iron and Steel Master," in *Profiles Out of the Past of Troy, New York Since 1789.* Troy, New York, 1946.

Reynolds, Clark. "The Great Experiment; Hunter's Horizontal Wheel," *American Neptune,* XXIV (January, 1964), 6-7.

R. G. Dun & Co. Collection, Baker Library, Harvard University Graduate School of Business Administration, Boston, Mass..

Ridgely-Nevitt, Cedric. *American Steamboats on the Atlantic.* Newark, Delaware, 1981.

Records of the Office of the Chief of the Bureau, Entry 5, section 7, Miscellaneous Correspondence, 1842-1885. Letters Received, RG71, Records of the Bureau of Yards and Docks, National Archives, Washington, D.C.

Records of the United States General Accounting Office, RG231. Fourth Auditor Records, National Archives, Washington, D.C..

Report of the Secretary of the Navy in Relation to Armored Vessels. Washington, D.C., 1864.

Rosenberg, Nathan, ed. *The American System of Manufactures.* Edinburgh, Scotland. 1969.

_____, *Technology and American Economic Growth.* New York, 1978.

Scharf, J. Thomas. *History of Baltimore City and County.* Philadelphia, 1881.

_____, *Chronicles of Baltimore.* Baltimore, 1874.

Sharkey, Robert P. *Money, Class, and Party: An Economic Study of Civil War and Reconstruction* (Baltimore, 1959).

Schenectady City and County Directory for 1862. Schenectady, N.Y., 1862.

Sloan, Edward William. *Benjamin Franklin Isherwood, Naval Engineer.* Annapolis, 1965.

Smith, Henry P. *History of Buffalo and Erie County.* 2 vols., Syracuse, N.Y., 1884.

Stiles, Henry R. *The...History and Commercial and Industrial Record of the County of Kings and the City of Brooklyn, N.Y., from 1633 to 1884.* 2 vols., New York, 1884.

Strong, George T. *Diary.* Allen Nevins and M. H. Thomas, eds., 4 vols., New York, 1952.

Still, William N., J. "The Historical Importance of the USS *Monitor,*" unpublished MSS in possession of author.

Strassmann, Wolfgang P. *Risk and Technological Innovation: American Manufacturing Methods During the Nineteenth Century.* New York, 1959.

Swank, James M. *History of the Manufacture of Iron in All Ages.* Philadelphia, 1892.

Swann, Leonard A., Jr. *John Roach, Maritime Entrepreneur.* Annapolis, 1965.

Syrett, Harold C. *The City of Brooklyn, 1865-1898.* New York, 1968.

Taylor, George Rogers. *The Transportation Revolution, 1815-1860.* New York, 1951.

Temin, Peter. *Iron and Steel in Nineteenth-Century America: An Economic Inquiry.* Cambridge, Mass., 1961.

The Argument of Mr. Edward N. Dickerson...In the Case of Sickels vs. Borden, Defended by 'the Novelty Iron Works' and Mr. Horatio Allen. New York, 1856.

The Buffalo City Directory for the Year 1862. Buffalo, 1861.

The Manufacturing Interests of the City of Buffalo. 2d edition, Buffalo, N.Y., 1866.

The Nautical Gazette, January 13, 1875.

"The Novelty Works," in *Harper's New Monthly Magazine,* II (May, 1851), 721-734.

The Scientific American

"The Shipbuilding Industry in Brooklyn," *Brooklyn Life,* LIX (April 26, 1919), 139-146.

The Troy Directory for the year 1861. . . . Troy, n.d.

The War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies. 130 vols., Washington, D.C., 1880-1901.

Thurston, Robert H. *A History of the Growth of the Steam-Engine.* New York, 1878.

Troy Business Directory for the Year 1861. . . . Troy, N.Y., 1860.

Transactions, American Society of Mechanical Engineers, X (October, 1888), 386-388.

Tyler, David B. *Steam Conquers the Atlantic.* New York, 1939.

Walkowitz, Daniel J. *Worker City, Company Town: Iron and Cotton-Worker Protests in Troy and Cahoes, New York, 1855-84.* Urbana, Illinois, 1978.

Wallace, David H. *John Rogers; the People's Scuptor.* Middletown, Conn., 1967.

Watts, Gordon P., Jr., "Monitor of a New Age: The Construction of the U.S.S. *Monitor.*" M.A. Thesis, Easton Carolina University, Greenville, N.C. 1975.

Wegner, Dana M., "Alban C. Stimers and the Office of the Inspector General of Ironclads, 1862-1864." M.A. Thesis, State University of New York, Oneonta, 1979 26-34.

_____, "Ericsson's High Priest," *Civil War Times Illustrated,* XII (February, 1975),

Weise, Arthur J. *Troy's One Hundred Years, 1789-1889.* Troy, N.Y., 1891.

Welles, Gideon. *Diary of Gideon Welles.* ed. Howard K. Beale, 3 vols., New York, 1960.

Westover, Myron S., ed. *Schenectady Past and Present.* Strasburg, Va., 1931.

Wheeler, Francis B. *John F. Winslow, LL.D. and the Monitor.* Poughkeepsie, N.Y., 1893.